HiCoPro
Performance Athletics

September 15, 2015

DIRECTOR
Coach Rake, BA, JD

FITNESS DIRECTOR
Matt O'Brian, BS, MS

MEDICAL DIRECTOR
Julie Rake, BS, MS, PA-C, Fellow in Integrative Medicine

Recruiting Fast-Twitch Muscle Fibers in Seniors

Coach Buddy Rake, BA, JD, Matt O'Brien, BS, MS, and Julie Rake, BS, MS, PA-C Fellow in Integrative Medicine

Athletes over the past ten to fifteen years have dramatically improved in size, speed, strength, agility, vertical, and all other parameters that can be used to measure athletic performance. How did it happen that a 250-pound lineman can routinely run forty times in under five seconds or high school basketball players can dunk with ease? Have athletes exceeded all our expectations with performance enhancing drugs, nutrition, or better coaching? The answer is no. All of the gains in every measurement of athletic performance are directly related to a dramatic change on the part of strength coaches regarding how to recruit additional muscle fibers and, specifically, fast-twitch muscle fibers.

When I became a high school basketball coach twenty-five years ago, it was the rare game that resulted in a player dunking the basketball. Strength training was an afterthought and, if done at all, it was done during the off season. This all changed in the early 2000s when strength coaches started to focus on the work performed by Suter, Herzog, and others.[i]

Most of us are composed of about 50% slow-twitch muscle fibers and 50% fast twitch. In the sports arena, coaches did a pretty good job of recruiting and strengthening slow-twitch fibers. Basically, we recognized the importance of core strength and strengthened the core by doing multiple sets and repetitions. When it came to fast-twitch muscle fibers, the standard training protocol was to lighten the loads and accelerate the time to lift and increase the repetitions. Players got stronger, but not because fast twitch muscle fibers were recruited or strengthened. As it turned out, the fast-twitch muscle fibers were the last fibers recruited and to recruit them without going into detail in this portion of the article, you have to maximize your effort during a lift. Coach O'Brien will discuss this in detail, but the basics are that in order to recruit fast-twitch muscle fibers you have to exert maximal effort. It is the recruitment of fast-twitch muscle fibers that are directly related to the dramatic rise in athletic performance.

What does any of this have to do with seniors or those over the age of fifty? The answer is everything. It also has great application to anyone regardless of age, who has sustained a decrease in strength from trauma or disease. Muscles are the body's shock absorbers and while an increase in athletic performance is a goal of strength training, injury prevention is equally important.

Eight years ago at the age of sixty and following a surgical procedure that resulted in a prolonged recuperation, I consulted with Coach O'Brien about how I could accelerate getting back on the court. Prior to the surgery, while I had considered myself cardiovascular fit, I left strength training to my players. Coach O'Brien came up with a program for me that included *both* cardio and strength training.

As I became more interested in accelerating my recovery and increasing my fitness, I began researching and reading a number of articles which, quite frankly, scared the living heck out of me. The fact that I had reached senior citizen status and that getting older had some medical significance had never occurred to me. I was a high school basketball coach and, up until the surgery, I played basketball with my players during the off season and had no physical limitations. I was not aware that medical professionals were predicting a gloom future.

The scariest word I have ever read or heard is not cancer, stroke, or heart attack. It is "*sarcopenia*," which means the degenerative loss of skeletal muscle mass as we age. One particular article from the Mayo Clinic predicted muscle loss, fractures, loss of balance, the inability to take care of yourself and, after age 65, a decrease in life expectancy if you broke a bone.[ii]

We lose about 7% of our muscle mass each decade after age thirty. As I struggled with the gloom and doom predictions of the medical community, I started thinking about what we had learned over the past ten years about fast-twitch muscle fibers. Was a senior citizen really much different than an incoming freshman? Most people have had very little experience with using a strength coach, much less someone with the qualifications of Coach O'Brien. It has only been since about the year 2001 that we started learning how to recruit fast-twitch muscle fibers. If they could still be recruited by seniors, then their recruitment would be life-altering.

I discussed this theory with James L. Frey, M.D., a prominent neurologist, who is director of the Stroke Center at St. Joseph's Hospital and Medical Center in Phoenix, Arizona. His conclusion was that if neuro pathways still

existed or could be established, then I might be right. Fast-twitch muscle fibers may be "lying on the shelf" waiting for activation.[iii]

Coaches are in the neuro pathway business. Repetition and the creation of neuro pathways is the foundation for teaching kids how to pass and shoot a basketball, and every other repetitive skill in sports.

If I was right and the neuro pathways existed or could be created, then the practical net effects of sarcopenia would be very little. If sarcopenia created a loss of muscle mass and corresponding strength at the rate of seven percent (7%) per decade starting at age thirty, then at age seventy you would have lost 30% of your muscle mass. Since most seniors have never recruited their fast-twitch muscles fibers, 70% of those muscles are still available for recruitment. Recruiting those fast-twitch muscles fibers to add to the reactivated slow-twitch muscle fibers, which can certainly be strengthened, and you could be as strong – or even stronger – than you were at age thirty.

I became Coach O'Brien's test subject. We set goals. I made sure he knew that I did not want to be treated different than our players. Coach O'Brien and I differed on implementation. I was excited about the theory and in a hurry to prove it. He pointed out that before we recruited the fast-twitch muscle fibers, we had to recruit the slow twitch and improve core strength. So we proceed from there exactly as if I was an incoming freshman. We started on the basic core strength program that he had implemented for our new players. As he pointed out, it would be foolish to try to recruit big muscle fast-twitch fibers without a good core foundation.

Ultimately, we finally moved on to fast twitch recruitment. I recalled that when I got out of the Navy in 1966 at the age of twenty-one that I could bench my weight and squat double my weight. Once we were able to recruit the fast-twitch fibers, I once again was able to bench press my weight and squat double my weight. I don't know how strong I am, but I am certainly as strong (and probably stronger) than I was in my thirties. Recently, I performed **six repetitions** on a leg press with over **1,000 pounds** at age 68. The focus should be on the age and not the weight. It would be impossible for someone sixty-eight years of age to lift 1,000 pounds unless fast-twitch muscle fibers had been recruited. I may have age-related sarcopenia, but the practical effect is negligible at worse.

The medical significance cannot be overestimated. Recruiting additional slow twitch and new fast twitch muscle fibers would eliminate or obviate many injuries and/or diseases.[iv] For example, most shoulder injuries in

seniors occur from weak quadriceps. To stand up, seniors use their arms because their quadriceps muscles are too weak and they end up with torn rotator cuffs. Just strengthening quadriceps would eliminate most shoulder injuries, and injuries resulting from falls would be greatly reduced.

This article, while focusing on muscle recruitment, approaches fitness from three different orientations: Coach, Strength Coach, and Medical professional. As a coach, I evaluate fitness levels from an athletic performance perspective every day. Players who are not fit cannot perform and it is dangerous for them to try, as they are more susceptible to injury. There are certainly skinny people who are not fit, but there are no fit fat people regardless of what the governor of New Jersey claims.

If everyone walked around the block once a day, lifted twice a week with someone like Coach O'Brien, and treated sugar like poison then there would be no healthcare crisis in America. As we enter our golden years, we have the choice of walking with friends or being pushed by strangers.

Methodology of Recruiting Fast-Twitch Muscle Fibers in Seniors

The resistance training methodology for combating sarcopenia in the population discussed in this paper will be presented in three sections: equipment, resistance training exercises, frequency, and training phases.

Equipment

- Smith machine
- 45-degree leg press
- Adjustable bench
- Lat pull down machine
- Physioball
- Resistance bands with handles; varying resistance
- Dumbbells; varying from 3lbs-25lbs
- Medicine balls; varying from 4lbs-20lbs

Resistance training exercise

Initially, the major lower body resistance training exercise was squats using the Smith machine. Using the Smith machine, allows for stabilization of the weight as well as better guidance of the bar for a more fluid motion during the exercise, which results in a decreased risk of injury. In the movement of the squat, the major muscles activated to perform the movements are the quadriceps and the gluteus maximus while the

gastrocnemius, rectus abdominus and erector spinea are used to stabilize the body. As training progressed and to further reduce one's risk of injury, the main lower body resistance training exercise was updated to the 45-degree leg press. The 45-degree leg press was chosen because of it keeps the individual in a fixed plane of motion which decreases the risk of lower body injury throughout the movement. The movement of the 45-degree leg press causes contraction of quadriceps as well as in the gluteus maximus.

The major upper body resistance training exercise was the bench press performed on the Smith machine. Using the Smith machine allows for stabilization of the weight as well as better guidance of the bar for a more fluid motion during the exercise, which results in a decrease in the risk of injury. The major movement of the bench press is caused by a contraction of the pectoralis major with assistance from the deltoids and triceps brachii.

The assistance upper body exercises were done using the resistance bands, which allows the individual to remain standing while they perform a chest press, row, or bicep curl. Keeping the individual standing causes the exercise to be more weight-bearing, as they have to support their own body weight and engage their core to perform the movements. The chest press with the resistance bands allows for activation of the pectoralis major with assistance from the deltoids and triceps brachii. This activity also allows the individual to perform the exercise without having to stabilize the movement and with much less risk of injury—compared to that of a dumbbell bench press. The movement of the row causes the activation of the latissimus dorsi, rhomboids, and deltoid. In the movement of the bicep curl, the major muscle activated is the biceps brachii.

The lat pull down machine is used as an assistance exercise to work the latissimus dorsi, by pulling the bar from the top of the machine to just in front of the chin. The lat pull down machine can also be used for tricep push down, by either using the straight bar that was used to perform the lat pull down, or switching the bar for a rope. As the person stands and pushes the bar or rope down, the triceps brachii are activated to perform the movement.

Using the dumbbells the assistant exercises of front raises and lateral raises can be performed. The movement of the front raises and lateral raises are caused by a contraction of the deltoid.

Abdominal work was done by doing crunches on the physiolball while holding the medicine ball.

Frequency

The frequency of the program was for two days a week with at least 48 hours in between two of the consecutive days, and 72 hours before starting the following week of training.

Training phases

Each training cycle lasts 11 months; each phase in the cycle lasts about six to eight weeks. The four phases that we focused on were hypertrophy, strength, multiple effort strength, and active recovery.

In the hypertrophy phase, each exercise is performed for 3-4 sets at 8-12 repetitions with a weight that is anywhere from 65-85% of their 1 repetition max. During this phase, the lifting techniques can be better taught and focused on.

In the strength phase, the pyramid scheme is used to maximize the effort and the recruitment of muscle fibers. Each of the major exercises is performed for 7-8 sets, with the repetitions varying from 10-1 as the weight increases from 65% to 95% or 105% of their 1 rep max. This was not a true pyramid as the weights and reps on the down sets did not match those on the way up. The reason for doing the pyramid was to maximize the muscle recruitment. At the top of the pyramid, the exercise a 1 rep max—or close to it—is performed. This is maximal effort recruiting all of the available type I (slow twitch) and type II (fast twitch) muscle fibers to push the weight. During the down sets, the muscle fibers are already recruited because the body believes that it is still lifting the 1 rep max, allowing for them to all be engaged as weight is lifted for various reps. During this phase, each of the major upper and lower body lifts was pyramided on separate days. The major lift, when it was not being pyramided, was performed at 4 sets of 8 repetitions at 75-80% of their 1 rep max. During this phase, the assistant exercises were done for 3 sets of 10-20 reps depending if the exercises were dumbbells or resistance bands.

In the multiple effort strength phase, each of the major exercises was performed using 5-6 sets of 10-3 repetitions as the weight increases from 65% to 85-90% of their 1 rep max. During this phase, the goal is to obtain multiple sets of 3 repetitions at as high of percentage of their 1 rep max as possible. As stated with the previous strength phase, the major lifts were not performed the same way on the same day. On the days that the major lift was not performing multiple effort strength, it was 4 sets of 8 repetitions at 75-85% of their 1 rep max. During this phase, the assistant exercises were done for 3 sets of 10 to 20 reps depending if the exercises were dumbbells or resistance bands.

The last phase is the active recovery phase. This phase, unlike the three previous phases, does not need to be six to eight weeks. This phase is usually last about 4 weeks at its longest, but one to two weeks are placed in between the various other phases. Active recovery is just that, active recovery. During this phase no weight training is performed but the individuals are doing active things, such as hiking or other recreational activities that require a moderate to vigorous effort.

ADDENDUM

THE HEALTH BENEFITS OF STRENGTH TRAINING

Strength training may be the best medicine. There are thousands of journal articles as well as fitness and health papers that delineate the benefits of strength training. An overview of these benefits include, but are not limited to: improved physical performance, movement control, increased muscle mass resulting in higher metabolic rate, lowered body fat, stronger skeletal components, walking speed, functional independence, improved cognitive abilities, reduced depression and anxiety levels, increased self-esteem and prevention of age-related disease processes. For the purpose of brevity, I will focus on those benefits most critical to prevention of disease and the aging process in seniors.

The first benefit I will focus on will be the physiology of hormones affected by strength training. The amount of fat and muscle a person has influences the hormonal system. Increased fatty tissue causes insulin and leptin resistance. Insulin resistance initiates the cascade of events that are present in the early stages of diabetes mellitus. Leptin inhibits food intake, reduces body weight and stimulates energy expenditure. When we understand the significance of insulin and leptin resistance, then we can see that having more body fat enhances the hormonal systems ability to store even more fat. Creating and sustaining more muscle mass achieved by strength training causes an increase in anabolic hormones. Anabolic hormones are known as muscle builders. Muscle is one of the locations where testosterone production occurs; thus, there is a direct relationship between the amount of muscle you have on your body and the amount of testosterone being produced. Increased levels of testosterone are more pronounced in men, but have numerous benefits, including increased energy and vitality, improved sexual function and improved sleep. Furthermore, the mere presence of increased testosterone encourages even more muscle growth. Strength training stimulates the pituitary gland to release growth hormone to promote muscle growth as well as stimulate the

body to metabolize fat. The increase in testosterone and human growth hormone in seniors not only slows the aging process, but it enhances vigor and vitality while halting deterioration of the hormonal cascade which supports overall wellbeing.

Strength training prevents osteoporosis. Osteoporosis is a disease characterized by the loss of bone density and bone tissue over time. As we learned above, strength training regulates and increases the hormones testosterone and human growth hormone. As these two hormones decline, bone density does so correspondingly. Testosterone and Human Growth Hormone have an anabolic effect on bones. Osteoblasts are the construction crews building bone, and Osteoclasts are the demolition crews tearing bone down; a process known as resoprtion. Testosterone inhibits bone resorption. In particular, growth hormone triggers the release of amino acids that speed up bone building. Furthermore, bones are not stagnant. They are living tissues that regenerate every day. Weight bearing puts stress on the skeletal bones causing the bone tissue to become more dense and strong. In addition, a 1994 study published in the Journal of the American Medical Association showed that strength training increased bone density and significantly reduced the risk of fractures in women aged 50 to 70.[v]

Strength training produces relief in arthritis. Tufts University recently completed a strength program with elderly subjects who suffered severe knee osteoarthritis.[vi] This sixteen week program supported the expected outcomes. Pain was decreased on average by 43%. Furthermore, strength training is just as potent, if not more, than medication. Strength training also increases a person's flexibility and balance. This results in an overall restoration of strength, stability and reduction of falls. This aspect alone prevents morbidity and significantly reduces mortality, as falls are a leading cause of preventable death in the aging population.

Strength training prevents heart disease by means of a variety of factors. First and foremost, increased muscle mass equates to increased metabolic rate resulting in lower body weight. The risk of heart and vessel disease is lower in individuals with lower body weight. As previously discussed, strength training increases insulin sensitivity while increased in fat tissue promote insulin resistance. Insulin resistance contributes to Diabetes Mellitus. In America, Diabetes Mellitus is occurring in epidemic proportions. Obesity and diabetes mellitus top the charts in promoting the physiologic cascade that contributes to the formation of heart and vessel disease. Strength training causes increased blood flow to the muscles, tissues and heart; resulting in improved vessel flexibility and lower blood

pressures and heart rates. Countless studies support that strength training has the effect of lowering LDL (bad cholesterol) and raising HDL (good cholesterol). It is commonly known that physical fitness, combined with diet, is simply the best approach to preventing heart attack, stroke, cognitive decline and general arteriosclerotic vessel disease.

Strength training reduces the risk of cancer. Although already well-established that cardiovascular activity reduces the risk of cancer, a 2009 study, which appeared in Cancer Epidemiology, Biomarkers & Prevention, examined the associations between muscular strength, overall and waistline fatness, and cancer deaths as distinct from cardiovascular fitness.[vii] The results showed that muscular strength was significantly inversely associated with cancer mortality. The study also showed that body fat was positively associated with rates of cancer mortality. Furthermore, the study found that muscular strength and cardiovascular fitness were only "moderately correlated". The particular mechanisms, in which strength training reduced cancer rates were due to the increased and improved hormone regulation mechanisms, reduced systemic inflammation, improved antioxidant defense, improved immunity and overall reduced adiposity.

Strength training lowers the incidence of depression, anxiety and insomnia by a host of mechanisms. Strength training increases levels of endorphins as well as the neurotransmitters norepinephrine and serotonin, which are critical in regulating mood and mental state. As these neurotransmitters increase and become abundant in the brain, sleep improves. This includes falling asleep faster, sleeping more deeply, sleeping longer with less and periodic awakening. As with depression, the sleep benefits gained through strength training are comparable to results expected from treatment with medication. Alzheimer dementia accounts for 50% of dementia cases, while vascular dementia accounts for 40%. Strength training cuts the risk of both types of dementia. It is now supported in multiple studies that strength training slows the progression of the neurodegenerative processes, such as Alzheimer's disease, mild cognitive impairment, and other neurological illness such as Parkinson's disease. These processes are halted secondary to improved brain circulation via increasing blood and oxygen flow to the brain itself. Furthermore, recent research supports that strength training promotes neurogenesis, which is the growth of new neurons in the brain.

There are too many advantages gained from strength training to delineate further without a full exposition on the subject. Among those not discussed herein include improved strength of ligaments and tendons, which

decreases the risk of injury and fracture. Immunity is certainly stimulated, which can prevent contracting common viruses. Moreover, research supports that common viruses like influenza causes inflammatory effects on the body that are profound and lasting. The prevention of sarcopenia (muscle loss) as one ages, ensures prolonged independence. Independence may constitute living without a cane or walker or simply living on one's own and taking care of oneself. This independence is a direct result of improved balance, which prevents falls, and improved strength to perform the daily tasks of living. Finally, strength training increases metabolic rate and works better than anything else for loosing that extra weight, tightening and toning the body, and improving posture. Therefore, the idea of looking and feeling great is well worth the effort because of the benefits it yields.

There is simply no better substitute for prevention. Chronic disease processes occur over time in varying degrees based on one's lifestyle and genetic blueprint. There is no definitive roadmap that will prevent early morbidity and mortality. However, most chronic illnesses that are sweeping the nation in epidemic proportions today are preventable by simply making lifestyle changes. In addition to a healthy diet, cardiovascular fitness, and stress management, we now know that strength training is a dynamic in the prevention of physiologic aging that has been previously ignored. Research will conclude that strength training begets a Fountain of Youth. As a medical provider who practices in family medicine, I have come to understand that 90% of the symptoms I treat each day are completely preventable. The unfortunate decline in the overall health of Americans is creating a burden on medical practitioners that is impossible to support. As the overall health of Americans continues to decline, pharmaceutical companies will persist in creating a mountain of pills endeavored at "fixing" various diseases and surgeons will carry on performing millions of procedures to repair what is preventable. Albert Einstein once said "Everything should be made as simple as possible, but not one bit simpler". We should heed this wisdom for the good of mankind.

---

[i] Mannie, Ken. Understanding the 5 Game-Changer in Strength and Conditioning: All educators in this profession need to know how these principles affect coaching. (www.coachad.com, May 2012).
[ii] Carmen Terzic, M.D. Medical Edge Newspaper Column: Stay Active to Slow Muscle Loss That Comes with Aging (Mayo Clinic, Rochester, Minn., April 20, 2012)
[iii] James L. Frey, M.D., St. Joseph's Hospital and Medical Center, Center for Neurology.
[iv] Julie Rake, BS, MS, PA-C. Addendum: The Health Benefits of Strength Training.
[v] Nelson, Ph.D., Miriam E., *et al.* Effect of High-Intensity Strength Training on Multiple Risk Factors for Osteoporotic Fractures: A Randomized Controlled Trial. (www.jamanetwork.com, December 28, 1994).

[vi] Baker KR, *et al.* The efficacy of home based progressive strength training in older adults with knee osteoarthritis: a randomized controlled trial. National Center for Biotechnology Information (www.ncbi.nlm.nih.gov, July, 2001).
[vii] Ruiz, Jonatan R., *et al.* Muscular Strength and Adiposity as Predictors of Adulthood Cancer Mortality in Men. Cancer Epidemiology Biomarkers & Prevention (www.cebp.aacrjournals.org, April 14, 2009).

About the Authors

Buddy Rake has been a high school basketball coach for twenty-five years. For the past nineteen years, he has been the Head Coach for the Varsity Boys' Basketball team at Thunderbird High School in Phoenix, Arizona. His varsity teams have won several Division Championships, State Runner-Ups and State Champion, and three Final Four appearances. Coach Rake has been selected twice by his fellow coaches as the All-Star Coach and he was named Arizona Coach of the Year in 2003. On January 24, 2013 Coach Rake achieved his 300th Varsity Win.

Matt O'Brien has been a strength coach for the Thunderbird High School Boys' Basketball team for eight years. He has also been a strength coach for the Los Angeles Dodgers baseball team and served as an intern with the U.S. Olympic Team. He earned his Masters of Science degree in Exercise Physiology from the University of Nebraska.

Julie Rake is a PA-C family practitioner. She is a *suma cum laude* graduate at Arizona State University Barrett Honor College where she earned her Bachelors of Science degree and A.T. Still University where she earned her Masters of Science degree. She recently graduated from a two-year Fellowship program in Integrative Medicine at the University of Arizona Medical School under the tutelage of Dr. Andrew Weil. Her current endeavors include research which focuses on the neurobiology of wellness as a result of contemplative practices with a focus on meditation.