

# **Eccentric Exercise for Health**

**By Rose Baca and Graduate Student Mentor, Jeremy Ducharme**

## **Introduction**

For many clients, muscle hypertrophy, increased sport performance, enhanced neuromuscular control, and effective rehabilitation are often their goal. Muscular contraction assists in eliciting these chronic adaptations. It is important to know that muscles can either contract concentrically or eccentrically. Concentric exercise is the active shortening of the muscle (1). Eccentric exercise is where there is an active lengthening of the muscle. Eccentric exercise can be thought of as “breaking” or slowing down because the lengthened muscle is absorbing energy that can be used as power (2). Muscles go through a stretch shortening cycle (SCC) and the eccentric phase is where the absorbed energy can be stored as elastic energy. The SCC is when there is an eccentric contraction followed by a concentric contraction. The muscle acts as a spring to contract and perform movements such as jumping or sprinting (2). Importantly, training the SCC may have critical implications for sport performance. Not only is eccentric exercise beneficial to performance but it is useful in a rehabilitation setting because it has a lower energy cost than the concentric part and produces more force (3). This review is going to be discussing the many benefits of eccentric exercise and how to incorporate this into your goals or perhaps even your client’s health and fitness goals. There are many applications for eccentric exercise such as hypertrophic effects, increasing sports performance, chronic adaptations, enhancing neuromuscular control, and benefits for rehabilitation.

## **Hypertrophy and Eccentric Exercise**

A common goal achieved with resistance training is muscular hypertrophy. When lifting weights, the muscle will undergo both a concentric and eccentric action. Within a muscle tissue there are many layers, and the smallest functional unit is the sarcomere. Whenever there is a concentric action, the sarcomeres shorten, whereas in the eccentric action, the sarcomeres lengthen (1). It is thought that eccentric exercise can contribute to hypertrophic effects since eccentric exercise is more damaging than concentric exercise. This is because when the muscle is lengthening, it is more susceptible to tears. A hypertrophic effect then occurs, because as the muscle is repairing, the torn tissue is becoming stronger to protect the muscle from this sort of injury happening again (1). It is also found that eccentric exercise, in terms of maximal strength can be anywhere from 20-50% greater than concentric exercise which is another speculation as

to why eccentric exercise can yield more hypertrophic effects (1). Although eccentric exercise can lead to hypertrophic effects, it's best to use a combination of both concentric and eccentric exercises since these are the two basic movements when it comes to resistance training (1).

Eccentric exercise can elicit great benefits for muscular hypertrophy as well as be a helpful tool in aiding in sports performance.

### **Sport Performance and Eccentric Exercise**

Eccentric exercise also plays a major role in sports performance. Specifically, injury prevention is key for allowing athletes to continue to perform at their best. Eccentric exercise has been demonstrated to be a helpful method in preventing hamstring injury which is the most common cause of injury in running based sports (4). To put this into perspective about 20% of professional soccer players will suffer a hamstring injury with a chance of the injury occurring again sometime in the future (4). A hamstring injury on average for these professional soccer players will yield about 17 days where the athlete is unable to compete or practice, which leads to a decrease in performance as well as a cost for these elite soccer clubs as high as \$328,256 depending on the player (4). It is believed that these injuries happen during the late swing phase during intense running. Many recent studies found that eccentric knee flexor exercises can prevent hamstring injury since the bicep femoris long head fascicle is increasing in length as well as the knee flexor gaining strength (4). Strength training is important to injury prevention since greater muscular strength is more resistance to strain (4). Based on previous research, strength training may be even more effective when focusing on the eccentric component of the lift. Hamstring injuries can be detrimental to performance but strength training with an eccentric component can help speed up recovery and get players back on the field as well as preventing another hamstring injury in the future. In terms of chronic adaptation, eccentric exercise can improve the mechanical function of the muscle better than other training regimes. It is especially helpful to improve strength, power, and speed. When eccentrically training, the muscle tendon unit adaptations are shown to be more explosive (6). Eccentric exercise can also increase concentric and isometric strength (6). The strength improvements can be attributed from neural, morphological, and architectural factors (6). Improvements in power have been found to be related to eccentric training and the improved ability to increase the recruitment of larger muscle units (6). Also, when there is an increase in motor unit firing frequency, this can also explain the increase in power such as during a vertical jump since more muscle fibers are being recruited (6).

Eccentric exercise, as mentioned earlier can cause greater hypertrophic effects in the cross-sectional areas of the muscle when compared to concentric exercise because there is high level of mechanical tension of the active motor units caused by the lengthening of the muscle (6). There are many chronic adaptations from eccentric exercise that can be implemented for sport performance as well as injury prevention. Next, the SSC will be discussed and how it contributes to sport performance when focusing on the eccentric aspect of it.

### **The Stretch Shortening Cycle (SSC) and Eccentric Exercise**

The SSC proves to be important when it comes to sports performance. For example, different sports yield different timing for their particular SSC. In sports such as volleyball and basketball there are slower SSCs since there is a long ground contact time and a high displacement (2). In sports with a lot of sprinting there is a fast SSC since ground contact time is shorter and they have a high angular displacement (2). In order to achieve an effective SSC, it is important to have an accentuated pre-activation of the muscles before touchdown, have a fast and short eccentric phase, then quickly making the transition into the concentric phase when you make contact with the ground. The reason for this pre-activation is to increase the muscle spindles sensitivity, which can help the reflex potentiation as well as stiffness during the eccentric phase (2). The SSC is highly dependent on the type of event the athlete is doing whether that be something with a lot of power or on the endurance side. The SSC can also be effected by how conditioned the athlete is and can aid in muscle efficiency (2). It is key to train the SSC according to you or your client's specific goals in order to yield the best results. Eccentric exercise is an important addition to almost any competitive sport for not only performance measures, but to prevent injury as well.

### **Neuromuscular Control and Eccentric Exercise**

Neuromuscular control is also important in preventing injury to the muscles and is increased by eccentric exercise. It has been thought in the past that strengthening alone can prevent muscle injury since the muscle is more resistant to strain, but with the development of research, it is found that eccentric exercise can increase motor control (5). If motor control is not adequate it could lead to compromised movement patterns that could result in injury. There are several underlying factors that eccentric exercise can modify such as sarcolemma activity, alpha motor neuron recruitment/firing, fiber typing, cross sectional area, pennation angle, and working range of motion which all contribute to neuromuscular control (5). Eccentric exercise can also

improve cortical neural control such as cortico-spinal excitability and brain activation which aids in sending signals to the muscles to enhance neuromuscular control and reduce injury (5).

Eccentric exercise can often be associated with DOMS (delayed onset muscle soreness) since eccentric exercise elicits more damage to the muscle and this negative connotation can lead to avoidance of this type of training. However, this is usually due to starting a program at an intensity that the body isn't used to and not gradually building up to that intensity. It is important to progressively increase the workload when doing any type of exercise, especially eccentric exercise in order to avoid injury and even overtraining. Eccentric exercise is a great way to improve neuromuscular control as well as be an effective addition to a rehabilitation program.

### **Rehabilitation and Eccentric Exercise**

Eccentric exercise is a popular choice for rehabilitation (3). It has a low energy cost even though it can generate a high force production. This can sound skeptical because eccentric exercise is associated with DOMS but the key to successful eccentric exercise is to gradually increase intensity over time to prevent injury, inflammation, and soreness (3). To put this into a practical example, Achilles tendinopathy (inflammation of the Achilles tendon) is a common injury mostly seen in the general population who run or play sports (7). It is possible that the eccentric exercise can strengthen tendon structure since it closely mimics sport specific movements such as repetitive force changes during the SSC (7). Eccentric exercise is also crucial for elderly adults who are limited in movement or those suffering from a chronic disease due to its low energy cost and high force production. It is crucial for these individuals to have weight bearing exercises in order to increase bone mineral density and prevent muscle wasting that can eventually lead to falls that could be devastating (3). Eccentric exercise is very attainable for the elderly population since this negative work has a lower rate of perceived energy than other exercises which increases compliance within this population (3).

### **Implement it**

When implementing eccentric training into an exercise or rehabilitation program, keep in mind that the client or patient may need assistance when lifting concentrically since the load may be heavier. This is because eccentrically they can lift more weight since eccentric contraction produces more force than concentric contractions. Eccentric exercise does not necessarily have to be done with extra weight either; body weight can also be effectively used, whether it is slowly lowering yourself from a pull-up or even walking downhill, eccentric exercise can be a

practical method to fit the client's needs (3). There are many possibilities when it comes to eccentric training such as these three methods that are commonly used; the eccentric emphasis training technique, the supramaximal training techniques, and the two up: one down technique. The eccentric emphasis technique is where the client will use a weight they normally use and spend one second in the concentric phase (i.e., lifting the weight) and three to four seconds in the eccentric phase (i.e., lowering the weight) (8). The supramaximal technique is where the clients will use 105% of what they normally lift and then would lower the weight with outside assistance and then lift the weight in 1-2 seconds. Assistance may be needed when lifting the weight (8). Lastly is the two up: one down technique which is only used on the arms and legs. Client will start with 40-50% of weight they normally use and then lift the weight with both limbs for one second, but only let down with one limb at a time for three to four seconds making sure to alternate the limb involved each repetition (8). Individuals have many options when it comes to implementing eccentric exercise into their particular fitness goal.

When it comes to eccentric exercise, there are a multitude of benefits that can be elicited based on the individual's goals or needs at the time. This can be anywhere from muscle hypertrophy, increased sport performance, enhanced neuromuscular control, and even effective rehabilitation. There are many options when it comes to eccentric exercises, and can be implemented in numerous ways to optimize the desired outcome. Eccentric exercise is very applicable, accessible, and a practical training program.

## **Elements Section**

### **1. Apply it**

Try these three eccentric methods when resistance training

**The eccentric emphasis technique:** The client will use a weight they normally use and spend one second in the concentric phase (i.e., lifting the weight) and three to four seconds in the eccentric phase (i.e., lowering the weight).

**The supramaximal technique:** The client will use 105% of what they normally lift and then would lower the weight with outside assistance and then lift the weight in 1-2 seconds. Assistance may be needed when lifting the weight.

**Two up-one down technique:** Start with 40-50% of what the client normally uses and then lift the weight with both limbs for one second and lower the weight with only one limb at a time for three to four seconds while making sure to alternate the limb involved each repetition.

## **2. Bridging the Gap**

Eccentric exercise can yield many benefits that encompasses various goals. These benefits include muscle hypertrophy, increased sports performance, enhanced neuromuscular control, and effective rehabilitation. Eccentric exercise can be an easy addition into any exercise program no matter the goal of your client.

## **3. Summary Statement**

Eccentric exercise is very applicable, accessible, and a practical training program that can be implemented to many different goals.

## **4. Pulled Text**

“It is thought that eccentric exercise can contribute to hypertrophic effects since eccentric exercise is more damaging than concentric exercise. This is because when the muscle is lengthening, it is more susceptible to tears. A hypertrophic effect then occurs, because as the muscle is repairing, the torn tissue is becoming stronger to protect the muscle from this sort of injury happening again.”

## **Bio:**

Rose Baca CPT, is currently pursuing a B.S. of Exercise Science at the University of New Mexico. Her interests include resistance training and tennis.

## **References**

1. Schoenfeld BJ, Ogborn DI, Vigotsky AD, Franchi MV, Krieger JW. Hypertrophic Effects of Concentric vs. Eccentric Muscle Actions: A Systematic Review and Meta-analysis. *The Journal of Strength & Conditioning Research*. 2017 Sep;31(9):2599–608.
2. Vogt M, Hoppeler HH. Eccentric exercise: mechanisms and effects when used as training regime or training adjunct. *Journal of Applied Physiology*. 2014 Feb 6;116(11):1446–54.
3. LaStayo P, Marcus R, Dibble L, Frajacomo F, Lindstedt S. Eccentric exercise in rehabilitation: safety, feasibility, and application. *Journal of Applied Physiology*. 2013 Jul 3;116(11):1426–34.
4. Bourne MN, Timmins RG, Opar DA, Pizzari T, Ruddy JD, Sims C, et al. An Evidence-Based Framework for Strengthening Exercises to Prevent Hamstring Injury. *Sports Med*. 2018 Feb;48(2):251–67.
5. Lepley LK, Lepley AS, Onate JA, Grooms DR. Eccentric Exercise to Enhance Neuromuscular Control. *Sports Health*. 2017 Jul 1;9(4):333–40.

6. Douglas J, Pearson S, Ross A, McGuigan M. Chronic Adaptations to Eccentric Training: A Systematic Review. *Sports Med.* 2017 May;47(5):917–41.
7. Jayaseelan DJ, Mischke JJ, Strazzulla RL. Eccentric Exercise for Achilles Tendinopathy: A Narrative Review and Clinical Decision-Making Considerations. *J Funct Morphol Kinesiol* [Internet]. 2019 Jun 5 [cited 2021 Feb 6];4(2). Available from: <https://www.ncbi.nlm.nih.gov/pmc/articles/PMC7739229/>
8. Week 10 Teaching Exercise [Internet]. [cited 2021 Apr 2]. Available from: <https://www.unm.edu/~lkravitz/Teaching%20Aerobics/March22toMarch26TeachEx.html>