

# [Isotonic contraction and the effect of load on skeletal muscles essay sample](https://assignbuster.com/isotonic-contraction-and-the-effect-of-load-on-skeletal-muscles-essay-sample/)

The job of the motor nervous system is to control certain elements in muscles simultaneously to ultimately produce movement. Movement of the body is the result of specialized cells directly associated with skeletal muscle. Skeletal muscles are voluntary muscle and must contract before movement can occur. We know the muscle team moving the arm is formed at the biceps and triceps. Biceps can bend the elbow, but by itself can not extend the arm. Biceps contract and triceps relax to flex the elbow. When the elbow is straightened, the reverse takes place; the biceps relax and triceps contract.

However, what happens during skeletal muscle contraction? For instance, what happens to the muscles in the leg when one lifts weights? We used two variables, muscle length and resistance; to explore how skeletal muscle speed and contraction is affected during an isotonic contraction when these variables are manipulated. We found if resistance is too light skeletal muscle contracts with ease and at a faster rate. However, if the resistance is heavy muscle contraction has a much slower rate. These findings give good insight into safety precautions, maintenance, and medical diagnoses’ of our body. For instance when lifting weights, or determining underlining causes of a heart condition. Introduction

The muscular system has more than 600 muscles (cardiac, skeletal and smooth muscle) throughout the human body. Contraction of these muscles is generated by specialized muscle cells. Skeletal muscles are voluntary and move the body by pulling on the bones, for instance, when throwing a ball or walking. This involves a series of steps in which bones are moved at the joint by a complex electrochemical and mechanical process of contraction and relaxation of skeletal muscles (Kendal et al., 2000). First, skeletal muscle fibers communicate with the nervous system at the neuromuscular junction (NMJ) by stimulating the sarcolemma. Through a process called excitation-contraction coupling where acetylcholine (ACh) is released into the synaptic cleft, opening sodium ion channels (Na+) and generating an action potential (AP). The AP causes the sarcoplasmic reticulum (SR) to release calcium ions (Ca2+) where cross bridges are formed and the muscle contraction cycle is initiated. During the contraction phase, the skeletal muscle shortens producing tension on the ends of the muscle. Next, the relaxation phase, ACh is broken down by acetylcholinesterase (AChE) and the AP is ended. The SR reabsorbs the Ca2+ and with no more cross-bridge interaction, the contraction ends returning the muscle to its resting length (Martini et al., 2012).

Muscles experience two basic types of contractions called isometric and isotonic. Isometric contractions occur when there is a rise in muscle tension, but the length of the muscle stays the same. Isotonic contractions occur when tension in muscle rises and the length of the muscle changes. This is usually associated with muscle moving something that is of a fixed weight. Our purpose is to “ describe the effects of resistance and starting length on the initial velocity of shortening and discover why muscle force remains constant during isotonic shortening” (Marieb et al. 2009). Our findings will provide improved understanding of how resting length will result in maximum force production in human muscles (Marieb et al. 2009). Materials

Materials used in the experiment include:   
Data collection unit, electrical stimulator, electrodes, force transducer, hooks, muscle support stand, myograph, oscilloscope display, platform height simulator, simulated muscle, voltage control simulator, and weights (grams): 0. 5-g, 1. 0-g, 1. 5-g, and 2. 0-g.

Methods   
Experiment 1: We began the experiment by placing a hook through the upper tendon of the muscle connecting it to the force transducer. Next, we suspended the muscle in the support stand and secured it with a second hook at the lower end of the muscle tendon. We set a platform height of 75mm, set the voltage to 8. 2 volts and added 0. 5-g weight onto the muscle’s lower tendon. Beginning experiment 1, run 1, we applied a stimulus to the muscle and simultaneously observed the muscle action. Data was recorded and a second run was completed after applying a 1. 5-g weight in which the data was also recorded. After we collected initial data results we continued the experiment for a 3rd and 4th run using 1. 0-g and 2. 0-g weights. After all four runs were completed we recorded the data and plotted the results. Experiment 2: First we cleared all pervious data from experiment 1 in the data control unit. We attached the 1. 5-g weight to the lower muscle tendon. Set the voltage to a maximum of 8. 2 volts. Beginning with 60mm length on the height platform we ran through a range of lengths beginning with 60mm to 90mm in 5-mm increments. Results from the seven runs were recorded in the data collector and we plotted the data for analyses. Results

Figure 1 shows a baseline experiment (run 1) and grid that graphically shows the contraction data for analysis. Time (in milliseconds) is along the horizontal axis and force (in grams) is on the vertical axis. We applied a 0. 5-g stimulus to the muscle and observed the oscilloscope tracing produced by the stimulus. We observed the tracing rise from the surface of the platform, flat line for a few seconds, followed by a rapid decline. The force produced remained constant and did not change during the flat line of the tracing.

Table 1 shows data comparing weight and rate of contraction between run 1 and run 2 (1. 5-g weight). The 0. 5-g weight resulted in the highest rate of contraction with a velocity of 3. 77 mm/sec. The arrow indicates the latent period in which no contractions occur.

Figure 2 shows a grid of the relationship between resistance and the initial velocity of shortening. Velocity (in mm/sec) is on the horizontal   
axis and weight (in grams) along the vertical axis. We completed the 3rd and 4th run with 1. 0-g and 2. 0-g weights and plotted the data of runs 1, 2, 3 and 4. The results showed the greater the resistance, the shorter the initial velocity of shortening or rate of contraction.

Relationship between starting length and initial velocity of shortening

Discussion   
Before we could begin our current experiment we had to determine how a muscle responds to a single stimulus and when does lengthening occur. We found that a muscle contraction in response to a single stimulus of adequate strength is called a muscle twitch. A complete muscle twitch has three phrases: 1) Latent period, during which there are no contractions. 2) The contraction period is when skeletal muscle contraction starts. 3) During the relaxation period, tension is reduced and the muscle returns to normal length (Marieb et al. 2009). Our results of experiment 1 showed a response to a single stimulus as related to twitch and phases. Furthermore, our research concluded when the load on a muscle exceeds the tension generated, a lengthening contraction occurs. Our experiment had two important variables, starting length of the muscle and the resistance applied. As illustrated in table 1 and figure 2, if the object is light it can be lifted quickly, however a heavier weight will be lifted with a slower velocity (Marieb et al. 2009).

Our findings in experiment 2 concluded the strength of a muscle contraction can be altered by changing the starting length of the muscle known as the length-tension relationship. Constant variables 1. 5-g weight and 8. 2 volts, with changes in muscle lengths. Our finding showed at 60 mm, the muscle is unstretched and produces a weak contraction because the overlapping thin filaments interfere and conflict with each other restricting cross bridge binding and less tension develops (Kendal et al., 2000). Muscle length of 75 mm, we found the muscle was moderately stretched indicating a moderate overlapping of the thin filaments relative to the cross bridges. Therefore maximum tension is developed and muscle contraction occurs (Martini et al., 2012).

Lastly, at 90 mm length, the muscle became over-stretched indicating the thick and thin filaments are overlapping only slightly. When over stretched the thin filaments are pulled almost to the ends of the thick filaments and very little if any tension can develop (Kendal et al., 2000). Our goal was to investigate how changes in muscle length and resistance affect the speed of skeletal muscle contraction (Marieb et al. 2009). We found that when a weight is not too heavy the muscle can lift it with a faster velocity. For example, when working out and completing bicep curls, a 2 pound weight can be lifted quickly compared to a 50 pound weight. Also, in human skeletal muscle overstretching rarely occurs but this is very important when considering heart muscle in relation to congestive heart failure.

References

Kandel, ER., Schwartz, JH., and Jessell, TM (2000). The Motor Unit and Muscle Action, Principles of Neural Science (chp. 34, 4th edition, pp. 675-683). New York: McGraw-Hill.

Marieb, E. and Mitchell, S. (2009). Investigating the Effect of Load on Skeletal Muscle. Laboratory Manual: Human Anatomy & Physiology, (Exercise 26, 9th edition, pp. 419-420). New York: Pearson Education Inc.

Martini, F., Nath, J. and Bartholomew, E. (2012). Muscle Tissue. Fundamentals of Anatomy & Physiology, (chp. 10, 9th edition, pp. 290-305). New York: Pearson Education Inc.