Factors That Determine Strength Potential

By Matt Brzycki

Have you ever noticed that some wrestlers make striking gains in strength while others make only modest ones — even though all of them may be performing the identical program in the weight room (that is, the same exercises using the same number of sets and repetitions)? In some cases, different responses to training may be the result of exercising with different levels of intensity. Most of the variations in the response to training, however, are primarily the result of an individual's genetic (or inherited) characteristics. Except for identical twins, each person is a unique genetic entity with a different strength potential.

GENETIC FACTORS

A number of genetic factors play a major role in determining your strength potential. These include the following:

Muscle-Fiber Type

One of the most influential of all genetic factors is your muscle-fiber type. Your muscle fibers can be categorized as slow twitch (ST) or Type I and fast twitch (FT) or Type II. From a functional standpoint, muscle fibers differ in a number of ways including speed of contraction, magnitude of force and degree of fatigability.

Most muscles have a blend of about 50% ST fibers and 50% FT fibers. (The fibers are intermingled throughout each muscle.) Some wrestlers, however, inherit a greater proportion of one fiber type that influences their strength potential. Due to their larger diameter, FT fibers produce greater force than ST fibers. Everything else being equal, wrestlers who have high percentages of FT fibers have a greater potential to improve their strength than others who have low percentages of FT fibers. It should also be noted that a wrestler's fiber-type mixture can vary from one muscle to another and may even vary from one side of the body to the other.

Incidentally, there is no scientific evidence that consistently and convincingly supports the notion that ST fibers can be converted into FT fibers or vice versa. It appears as if one type of muscle fiber may take on certain metabolic characteristics of another type but actual conversion does not occur. Stated differently, you cannot convert one fiber type into another any more than you can convert lead into gold.

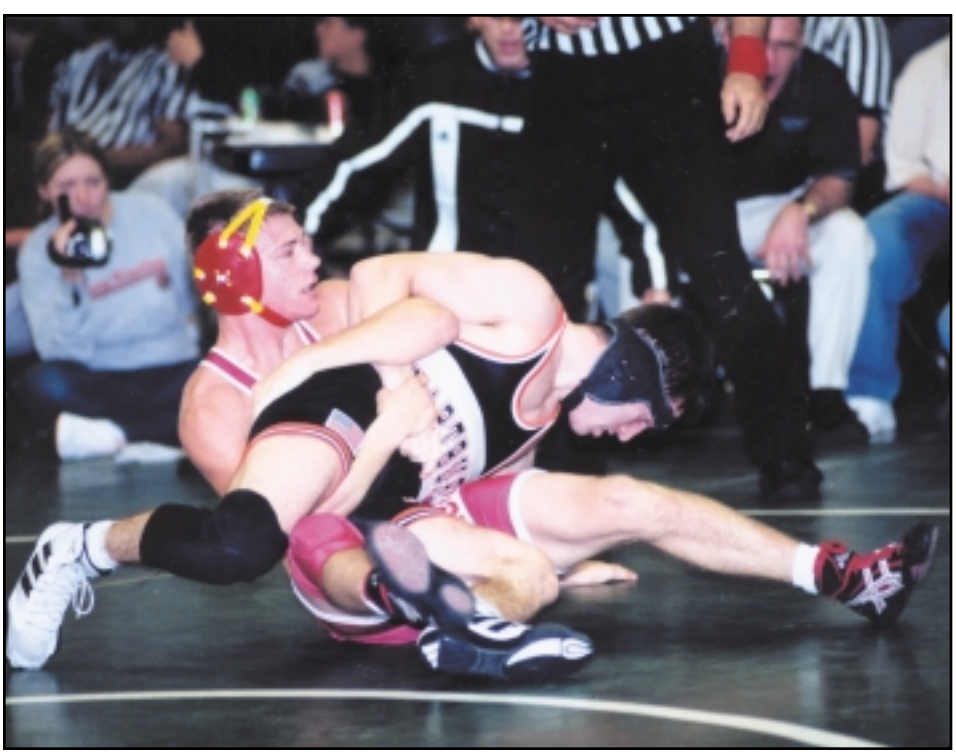
While on the subject, an increase in the number of muscle fibers — known as "hyperplasia" — is thought to take place by fiber splitting or "budding." Although hyperplasia has been demonstrated scientifically in many animals whose muscles were loaded with a resistance — including birds, cats and rats — there is no definitive proof that it occurs in humans. Most likely, strength training results in the addition of contractile protein — namely, actin and myosin — not in the addition of muscle fibers.

Muscle-to-Tendon Ratio

Another factor that determines strength potential is the relationship or ratio between the length of a muscle and the length of its tendon. The potential for a muscle to increase in size (or hypertrophy) is directly related to its length. Everything else being equal, wrestlers who have long muscles and short tendons have a greater potential for achieving muscular size than others who have short muscles and long tendons.

But how does this relate to strength potential? Well, a bigger muscle has a larger cross-sectional area. A larger cross-sectional area contains a greater number of protein filaments (actin and myosin) and crossbridges, thereby increasing its capacity to produce force. Therefore, a *bigger* muscle — in terms of its cross-sectional area — is also a *stronger* muscle. This means that wrestlers with long muscles have the potential to be quite strong. Understand, too, that a small variation in the length of a muscle makes a considerable difference in strength (and size) potential.

As with muscle-fiber type, a wrestler's muscle-to-tendon ratio can vary from one muscle to another. It is difficult to deter-



Harold Nichol's Open - 125 pound Ropp, Wartburg, decisioned Sundell, Iowa State, 7-6. Photo by John C. Johnson.

mine the actual length of a muscle because it may be hidden by subcutaneous fat (the fat between a muscle and the skin) or lie beneath other muscles. However, the lengths of the triceps, the forearms and especially the calves are usually easy to identify. The lengths of a muscle and its tendon are not subject to change.

Testosterone Level

Although it is a male sex hormone, testosterone is also found in the blood of perfectly normal women. In men, testosterone is produced by the testes; in women, roughly 50% is produced by the ovaries and 50% by the adrenal glands. The secretion of testosterone is regulated by pituitary hormones.

Testosterone influences the secondary sexual characteristics. In men, for example, it lowers the pitch of the voice and is associated with the growth of facial hair and, inexplicably, male pattern baldness. Additionally, testosterone stimulates skeletal growth as well as increases in muscle mass and strength. In short, its major action is to promote growth. Everything else being equal, wrestlers who have high levels of testosterone have a greater potential to improve their strength than others who have low levels of testosterone.

Interestingly, a number of studies have also found a correlation between testosterone levels and aggressive behavior in both men and women. This is not unique in the animal kingdom, by the way. Bull sharks have the highest levels of testosterone found in any creature (land or sea) and their aggressive behavior is legendary. It is, perhaps, the most dangerous type of shark in the world.

Lever Lengths and Body Proportions

Some wrestlers have lever (the bone) lengths and body proportions that give them greater leverage in the weight room and a greater strength potential than other wrestlers. For instance, those who are most successful in the bench press tend to have relatively short arms and thick chests. Everything else being equal, wrestlers with those lever lengths and body proportions have a greater strength potential in most pushing and pulling movements because they do not have to move the weight as far as others who have less favorable characteristics. Likewise, those who are most successful in the squat tend to have short torsos, thick abdomens, wide hips and short legs. Everything else being equal, wrestlers with those lever lengths and body proportions have a greater strength potential in squatting and deadlifting movements because they do not have to move the weight as far as others who have less favorable characteristics.

To illustrate, consider two wrestlers who are tasked with lifting 200 pounds in the bench press. Because of lever lengths and body proportions, suppose that Wrestler A has to move the weight a distance of 20 inches and Wrestler B has to move the weight 22 inches. Since "work" is defined as "force [or weight] times distance," Wrestler A must do 4,000 inch-pounds of work [20 inches x 200 pounds] and Wrestler B must do 4,400 inch-pounds of work [22 inches x 200 pounds] to accomplish the same task. In other words, Wrestler A does not need to make anywhere near as much effort as Wrestler B to lift the weight. Wrestler A would have greater leverage than Wrestler B and, everything else being equal, would have a greater strength potential.

Body Type

Another genetic factor that plays a critical role in strength potential is a wrestler's body type or somatotype. In the 1940s, Dr. William H. Sheldon — a physician and psychologist — proposed that there are three main body types: endomorph, mesomorph and ectomorph. Endomorphs are characterized by softness and round physiques. They have high percentages of body fat and very little muscle tone. A sumo wrestler is a classic example of an endomorph. Mesomorphs are typified by heavily muscled physiques. They have athletic builds with broad shoulders, large chests and slender waists. A competitive bodybuilder is a classic example of a mesomorph. Finally, ectomorphs are characterized by long limbs, leanness and slender physiques. They have low percentages of body fat but also little in the way of muscular size. A successful long-distance runner is a classic example of an ectomorph.

Since almost everyone has some degree of each component, various rating systems were developed in which an individual is given a "score" in each of the three areas. The system that was developed by Dr. Sheldon introduced a scale that ranged from 1 to 7 to designate the degree of each of the three components with 1 being the least amount and 7 being the greatest. In his system, a somatotype of 7-1-1 indicates extreme endomorphy (fatness), 1-7-1 extreme mesomorphy (muscularity) and 1-1-7 extreme ectomorphy (leanness).

Relatively few wrestlers can be classified as being purely one body type or another. Although wrestlers have a tendency toward one body type, most are a combination of two types. For example, a wrestler who has a somatotype of 1-4-4 would have a slender physique, a low percentage of

body fat and a high degree of muscular development and be characterized as an ecto-mesomorph; a wrestler who has a somatotype of 4-4-1 would have a round physique, a high percentage of body fat and a high degree of muscular development and be characterized as an endo-mesomorph.

A number of studies have related body type to physical performance. As you might suspect, the body type that has the greatest strength potential is the mesomorph. Everything else being equal, wrestlers who have high degrees of mesomorphy have a greater potential to improve their strength than others who have low degrees of mesomorphy. (A study of athletes who competed in the 1968 Olympics found that the average somatotype of a wrestler was 2.2-6.3-1.6, indicating a high degree of mesomorphy.)

Tendon Insertions

At one time or another, you probably encountered wrestlers who were far stronger on the mat than they appeared. In fact, they may have been incredibly strong despite not having much in the way of muscular size. How is this possible if muscular strength is directly related to muscular size (in terms of cross-sectional area)? One possible reason is that the wrestlers may have favorable points of tendon insertions. The fact of the matter is that the farther away a tendon inserts from an axis of rotation the greater the biomechanical advantage and strength potential.

Consider two wrestlers who are tasked with holding 100 pounds a distance of 12.0 inches from their elbows while keeping their lower arms parallel to the ground and maintaining a 90-degree angle between their upper and lower arms. Suppose that Wrestler A has a bicep tendon that inserts on the forearm 1.2 inches from the elbow and Wrestler B has a bicep tendon that inserts on the forearm 1.0 inch from the elbow. In this example, the force necessary to maintain the weight (or resistance) in a static position can be calculated by using this formula: "force times force arm equals resistance times resistance arm" or, more simply, "F x FA = R x RA." The force arm is defined as "the distance from the axis of rotation [in this case, the elbow] to the point where the force is applied" (the insertion point of the tendon); the resistance arm is defined as "the distance from the axis of rotation to the point where the resistance is applied." Inserting the previously given values into the formula reveals that Wrestler A must produce 1,000 pounds of force to hold the 100-pound weight in a static position while Wrestler B must produce 1,200 pounds of force to accomplish the same task. In other words, Wrestler A does not need to make anywhere near as much effort as Wrestler B to hold the weight. Wrestler A would have greater leverage than Wrestler B and, everything else being equal, would have a greater strength potential.

This depiction of static forces is somewhat simplified. However, it still illustrates the fact that a very small difference in the insertion point of a tendon can make a considerable amount of variation in leverage. Magnetic resonance imaging (MRI) and X-rays can be used to accurately determine the insertion points of tendons.

Neurological Efficiency

One more genetic factor that has a role in determining strength potential deals with the nervous system and has been termed "neurological (or neuromuscular) efficiency." This refers to an individual's inherited ability to recruit (or innervate) muscle fibers and is another reason why some wrestlers may be far stronger than they appear. It has been suggested that some individuals can recruit high percentages of their muscle fibers which gives them a greater potential to improve their strength than others who can recruit low percentages of their muscle fibers.

Consider two wrestlers who have the same amount of muscle mass. Suppose that Wrestler A can recruit 40% of his muscle fibers and Wrestler B can recruit 30%. Wrestler A would be able to access a higher percentage of muscle fibers than Wrestler B and, everything else being equal, would have a have a greater strength potential.

HERITABILITY VERSUS TRAINABILITY

With all due respect to Abraham Lincoln, all wrestlers are not created equal. If two wrestlers use the exact same method of training, it is highly unlikely that they will end up having the exact same level of strength. Each wrestler responds in a different manner because — except for identical twins — each wrestler has a different potential for improving strength. Simply, some wrestlers are predisposed toward developing high levels of strength while others are not.

So, your response to training is not necessarily due to a particular program or routine. Indeed, following the routines of successful weightlifters does not mean that you will attain their same levels of strength. Think about this analogy: If you were to train a racehorse like a draft horse, you might get a slightly stronger racehorse but you will never get a draft horse. The next time that you are in the weight room, observe different pairs of training partners. You will see that wrestlers who work out together usually have different levels of strength (and size) — despite doing the same exercises while using the same number of sets and repetitions.

The truth is that heritability dictates trainability. Your response to training is largely determined by your genetic characteristics. The cumulative effect of your inherited muscular, mechanical, hormonal and neural qualities is what determines your strength potential. A wrestler who has a high percentage of FT fibers, long muscles coupled with short tendons, high levels of testosterone, favorable lever lengths and body proportions, a high degree of mesomorphy, low points of tendon insertions and an efficient neurological system would be incredibly strong (as well as physically impressive). Compared to the average person, this genetic marvel would be capable of almost unbelievable feats of strength. There are some wrestlers like that but most are not as fortunate.

For all intents and purposes, you cannot change the characteristics that you have inherited from your ancestors. But this does not mean that you cannot get stronger. Regardless of your genetic destiny, your goal should be to realize your strength potential.

Matt Brzycki has been involved in the strength and conditioning of collegiate wrestlers for more than 20 years. Since 1986, he has authored more than 70 articles for *Wrestling USA Magazine*. Reprints of 42 of these articles have been updated and adapted into book form (Wrestling Strength: The Competitive Edge and Wrestling Strength: Prepare to Win) and are available through Cardinal Publishers Group (800-296-0481). He is also the author of A Practical Approach to Strength Training and the editor of Maximize Your Training, a 455-page book that features chapters written by more than 30 strength and fitness professionals.