The Concept of Strength

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What is strength? When we say that an individual is strong, what do we mean? That he can lift 200 lbs., dance a full evening-length ballet, run twenty miles, or live 100 years? The capacity to do one of these things does not in itself convey the ability to do any of the others. Since each activity operationally defines strength in a specific way, we can see that some definitions of strength pertain to immediate muscular energy output and work, while others pertain to systemic, structural abilities to resist stress. While strength is an issue of great concern in many fields of physical endeavor, it remains essentially undefined.

All definitions of strength have something to do with energy production, whether on an immediate muscular or long-term systemic basis. Therefore, the processes involved in the physiological production of energy are vital in any discussion of strength. Some of these areas, such as the absence of pathological conditions, good circulation, etc., come under the general heading of "health." Cardiovascular health depends partially upon the innervation and blood supply to the heart tissue itself. Cardiologists generally believe that exercise benefits the heart by promoting ample cardiac circulation. Various elements in the supply of oxygen to muscle tissue, including lung health and hemoglobin content of the blood, are important to energy production, but they do not in themselves constitute strength.

Energy output to a large extent depends upon the metabolic fuel available to muscle and other tissues in the form of ATP, which is prepared by various means by the body from foodstuffs. Nutrition, then, can be seen as a primary factor in the determination of strength because of its importance in the production of energy. Possible energy output is proportional to energy input within certain limits, and it is also dependent to some extent upon other factors, such as the presence of non-caloric nutrients (vitamins, minerals).

Past as well as present nutrition plays an important role in strength. The physical nature of the materials which make up the body is determined by what kinds of nutritional substances were originally available during gestation and growth. Sound structure can also serve as a reservoir for metabolic substances, such as calcium, in times of stress. Dr. D. G. Campbell examined dancers who were eating at semi-starvation caloric levels with severe deficiencies in many nutrients, yet they were able to function at a high level of energy output. He hypothesized that they were operating on the virtues, if you will, of past good nutrition experienced in childhood. 1 If good early nutrition provides long-term resources, poor early feeding can produce the opposite, as in the case of childhood rickets and some kinds of goiter. Beyond childhood, long-term deficiencies can take their toll. A low calcium diet can result in calcium being withdrawn from bones for immediate metabolic use (believed linked to osteoporosis), 2 resulting in a structure with weak, brittle bones, more susceptible to the shearing and other physical forces in the environment, less capable of recovery from injury. A diet low in vitamin C can result in poor quality collagen, with consequent excessive capillary breakage (causing bruising and, in the premorbid condition, scurvy). Such a structure would be less elastic and more susceptible to gravitational stress.

Strength is scientifically defined as the ability to do physical work (i.e., to move masses), and the greater the strength, the more mass can be moved. The virtue of this definition is its simplicity and the ease with which strength can be measured. Its drawbacks lie in the lack of correlation with other ways of measuring strength (the amount of available energy), to be discussed later, and in the myriad misinterpretations about the application of this definition to the human body. These misinterpretations lead to certain ways of using the body, which are aimed at increasing strength but actually result in a net reduction in energy output.

According to some interpretors, a good indication of strength is the size of the muscles involved, particularly when they are contracted. Therefore, strength can be attained by making muscles larger ("developing" them). In addition, "strong" muscles when at rest should always be slightly contracted, never completely relaxed, giving them "tone."

The belief in the value of muscular "development" has led to much kinesiological analysis of the mechanical workings of various isolated parts of the body, and countless exercises to "strengthen" various muscles or muscle groups. These exercises usually involved demanding a progressively more difficult task of the muscle group, for instance in terms of weight lifted. Over a period of time, if the training is correctly carried out, these muscles will adapt to the increased demand and become able to adequately perform the given task. "Strength," once attained, must be maintained by a similar regimen. In time these muscles will lose both bulk and the ability to perform at criterion levels if the training exercises are completely discontinued.

If a body is strong when certain muscles are well "developed", why doesn't it stay that way? In order to understand what happens, we must consider the plastic nature of the human structure in the creation of this "strength." The development of large and bulky muscles which are also relatively inelastic is the end product of the body's response to a specific kind of stress, the exercises in question. This response begins with the immediate reaction of adrenal activity, increased utilization of blood sugar, increased respiration, etc., during the stress itself. When the exercise is repeated many times, more permanent changes occur to help the body to perform without creating a new emergency each time. The body's response to this stress is the thickening and loss of elasticity in the fascial envelopes which surround the exercised muscle groups.

The build-up of connective tissue creates imbalances in the body which remain over a long period of time. When the body is stressed by severe exercise, its normal proportions and weight distributions become distorted, and various imbalances are created. When the stresses are removed, the body attempts to rebalance itself. This rebalancing may take a very long time, and is rarely completely successful. The resorption of built-up connective tissue, for instance is a slow process because it is not served directly by the circulatory system. The Connective tissue changes are accomplished by interstitial fluid circulation, a much slower process. The success of the rebalancing efforts also depends upon the type of imbalance present: top-bottom, side-side, front-back, or intrinisic-extrinsic (core-sleeve). One result of the overdevelopment of weight lifting muscles is the imbalance between the body's sleeve and core structures, between extrinsic (large, superficial) and intrinsic (deep) musculatures. The health of many other systems in the body, such as circulatory and digestive systems, seem to be very closely linked to the health of the intrinsic musculature or core structure. For instance, lymph circulation is partially dependent upon the activity of deep, intrinsic muscles. If large extrinsic muscles become so overdeveloped in bulk that they literally squash the inside of the body, there is neither room nor blood supply for the vital internal muscles and organs. Under emergency conditions, however, extrinsic muscles have priority stuatus for blood supply over intrinsic muscles and also, for instance, over the digestive system. In a fight-or-flight situation this has obvious evolutionary advantages. However, the system of weight training, of repeatedly inducing emergency reactions, creates an artificial situation of clear disadvantage. The lifespan of the individual may be shortened, and his health impaired as a result of the body's response to continual emergency, and the consequent imbalances and misuse of certain tissues. Individuals whose life styles are intimately involved with these exercises, such as professional weight lifters, are known to suffer from many problems such as high blood pressure, atherosclerosis, constipation, etc. These disorders may be seen as the the result of the imbalance between intrinsic and extrinsic musculatures.

The loss of balance between core and sleeve structures is not the only long term result of weight lift training and other stressful regimens. The bulk and in-elasticity of "developed" muscles can disturb the relative structural roles of bone, connective tissue, and muscle. Ideally, the soft tissues of the human body are balanced around the bones, the organ of weight transfer. Muscles come into play when movement or the cessation of movement is required, but are not used for support in a relaxed, balanced posture. If the bones of the weight supporting structure (spine, legs, etc.) are not well-organized vertically, then, muscular tension (chronic partial contraction with accompanying localized connective tissue build-up) is necessary to maintain the erect structure. For instance, individuals who carry their heads in front of their spines frequently complain of pain and stiffness in the trapezius and erector spinae muscles which are forced to carry part of the weight of their skulls. Weight lifting and other exercises can create these imbalances by changing the bulk of position of body parts, by over-shortening in some places, and consequent lengthening in others, and other functional distortions of ideal body alignment. This condition of imbalance represents a misuse of the organ of movement, the musculature, and an essentially unproductive expenditure of energy. The maintenance of exaggerated muscle "tone" is another example of unecessary continual muscular activity and loss of available energy. The more muscular energy used for the support and splinting-up of various body parts, the less energy becomes available for the life activity of movement. Thus, the imbalancing of the body in muscular "development" results in a net **loss** of available energy. Since strength is somehow proportional to available energy, it is clear that this method of attempting to increase strength actually diminishes it.

However, not all methods of exercise may produce bulky, inelastic musculature. Isometric exercise is one example where strength (as the ability to move mass) may be produced without an increase in overall tissue bulk. Dance, in some of its varied techniqes, can result in long, relatively unbulky muscles, rather than short "developed" ones.

Muscles may be strong (in the sense of being able to do much work over a long period of time) without being bulky. Some researchers (V. Hunt of UCLA)[3] have suggested that this is accomplished through increased innervation of the muscular tissue. Muscle fibers contract when chemical messengers from nerve endings create the necessary reactions. The more nerve endings in a given muscle, the more chemicals can be released, and the greater the ability of the muscle to contract. Nerves also cause muscles to contract in different ways, with different dynamics (smoothly or percussivly, for example), and in different combinations of muscle groups. For any given movement task, there are a variety of kinesthetic answers. Individuals develop preferences for doing movements in certain ways, and these are not always the most effortless ways of moving. The more a particular neural pathway is used, the more likely it is that it will be used again. Certain situations may cause the individual to seek new patterns of movement, to use different neural pathways; usually this kind of change requires great awareness. When an individual uses his musculature in different ways, he then has a choice of how to move and is free to discover and use the most efficient movements.

The amazing potential for work inherent in the musculature is demonstrated in those rare instances when individuals execute "impossible" feats, such as women lifting automobiles from their trapped children. The stress of the emergency creates a situation in which all of the available neural endings are utilized to activiate the muscle to its full potential.

Strength may be viewed in terms other than those of muscular power. It may be seen as a function of the total organism, of the whole man, in his environment. Strength is related to both available energy and to resistance to stress in man's surroundings.

What is man's environment? In physical terms, the most pervasive force in man's environment is gravity. No single other force has so deeply determined structure. Gravity has affected man's form and function throughout his evolution, and throughout his individual lifetime. Strength is related to the proper use of man's structure within a gravitational field.

Man's erect posture is not a second-rate compromise between four limbs and the necessity of having two free, it is a positive and advantageous adaptation to living in a gravitational field. In such a field, there are two stable positions, horizontal and vertical. Few land animals other than worms and snakes are truly horizontal. Perhaps only man evolved a vertical structure because most quadrupeds are dependent upon their greater speed, either chasing or fleeing, for immediate individual survival. The stability and efficiency of man's structure is a function of its verticality, and its balance when in this orientation.

Man's vertical stance is one of great potential energy. Relatively little energy is required to initiate movement; the individual has only to shift weight slightly, to imbalance himself slightly, and gravity will pull him in that direction. For instance, man's unique gait, the walk, can be seen as a process of falling forward, and swinging a leg out to catch the fall. Compare this with the walk (an entirely different gait) of fourlegged animals, in which the animal must push itself forward throughout the stride. Man's structure has other advantages, such as the height of his eyes and consequent long range vision, and an unusually short moment of rotation.

The ultimate test of strength may well be that of longevity. Man's structure has a certain potential for strength by virtue of its erect postural design. Perhaps it has contributed to man's unusually long life span by providing this unique harmony with the environment of gravity. Mammals of similar body weight but different postural orientations may live 30 years, in rare exceptions 40 or 50 under the best of care, but these figures are a small fraction of the 130 years reported for highly nontechnological peoples, such as tribesmen in the Peruvian Andes, or the Hunzas.

From individual to individual, the perfectness of this verticality varies considerably. In comparing individuals' strength, therefore, the criterion of closeness to vertical can be applied. Strength is commonly measured by energy output, often judged by the ability of muscles to do work. However, available energy depends upon harmony with the physical environment, specifically gravity. Strength may be seen as balance within a gravitational field; this includes the corollaries of the proper use of man's given structure, which is designed to function vertically, and the availability of energy on both short and long term bases.

Strength is operationally defined in a number of ways, which all include the level of available energy. Nutrition is of importance in determining the amount of this energy, and of tissue quality in an individual. Some attempts to increase strength develop huge muscles by subjecting the body to severe imbalancing stresses. Power as developed by these methods is transient, and results in a net loss of energy and movement capabilities. Other systems of exercise can lead to an increase in muscular innervation.

Strength is here related to appropriate structural balance within a gravitational field. The advantages of this balance relative to overall energy output and ease of movement are many, both in terms of individual and evolutionary benefit. True strength consists of harmony with the physical world; the reward of strength is a generous increase in the available energy that is, according to Blake, eternal delight.

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2. Lutwak, Leo, statement made at press conference, National Dairy Council conference, 1972.

3. Hunt, V. The biological organization of man to move. *Impulse*, 1968, pp. 51-64.