Isometrics Training

Isometrics
The Regulation Of Muscular Strength

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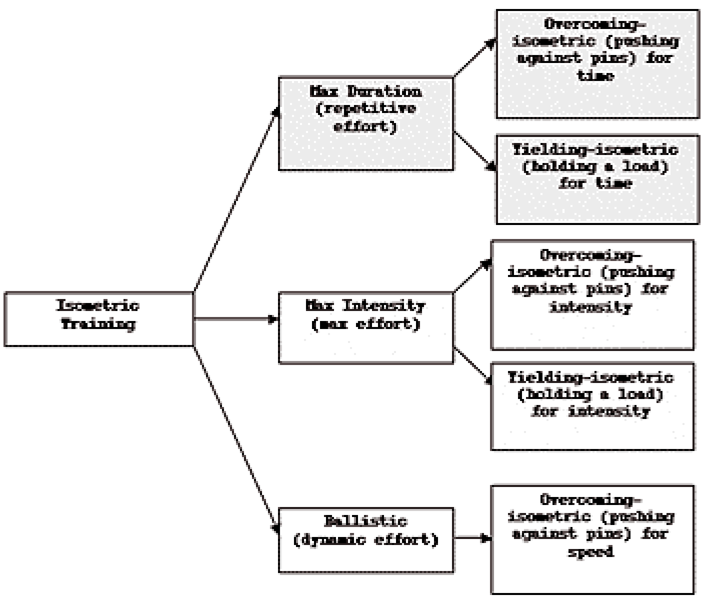
Side Bar

What you are about to read is the original work on **isometrics** from the researchers that started it all. Although it can be some what difficult to understand at times... rest assured that if you are interested in building muscle size, muscle strength and mass.

Then this is the one article you should read on **isometric training**

Introduction To Isometrics



When our investigations on the physiology of muscular strength and training were first undertaken, little knowledge was available either from experimentation or from practical experience in this field. Isometrics and Isometric training were too new.

Little attention had been given to problems such as whether common muscular strength is an equilibrium between activity and inactivity, whether it is regulated by inherent conditions and whether it is possible to alter the regulated level of strength.

An excellent review of the last half century of research in this field was given by Steinhaus in this Journal in 1955.

What was clearly established by the work of Petow and Siebert (1925)[2] and Siebert (1928) is the fact that nothing but an increase in intensity of work above that previously demanded of a muscle is the stimulus for an increase of muscular strength.

How Strong Can You Get With Isometrics Training

An answer for the fundamental question how strong, how long, and how often this stimulus must operate to get an increase of strength and how weak or how seldom, on the other hand, in order to get an atrophic decrease, was never investigated.

The advantage of using Isometric contraction for the measuring and training of muscular strength.

All our training was done with isometric contraction for the following reasons:

1.The maximal strength possible in a certain position during a moment is much lower than the strength in the same position reached with a static contraction.

2. Due to the influence of mass and speed it is not possible to get strictly isotonic contractions in man, except with very low speed. It is therefore difficult to determine the identity of the stimulus exerted on the muscle fibers during dynamic training.

It is even more difficult to measure strength and its increase or decrease by measuring maximal dynamic work. Maximal dynamic work depends as much on the blood supply to a muscle as on muscular strength.

Whereas maximal work increases roughly proportionally to muscular strength, it rises in a hyperbolic curve with a steady increase in blood supply.

Speed Of Movement

As we know from the work of A. V. Hill, maximal work is moreover influenced by the speed of movement.

Such... difficulties have to date obscured and confounded interpretations of results from training experiments with dynamic work whereas training with isometric static contractions has permitted the drawing of valid conclusions.

Dynamometry And Isometrics Training

We used types of dynamometers, usually heavy springs, that were extended no more than a couple of millimeters, enlarged sufficiently on a scale that permitted readings with as error no greater than 5%. (similar to the Bully Xtreme)

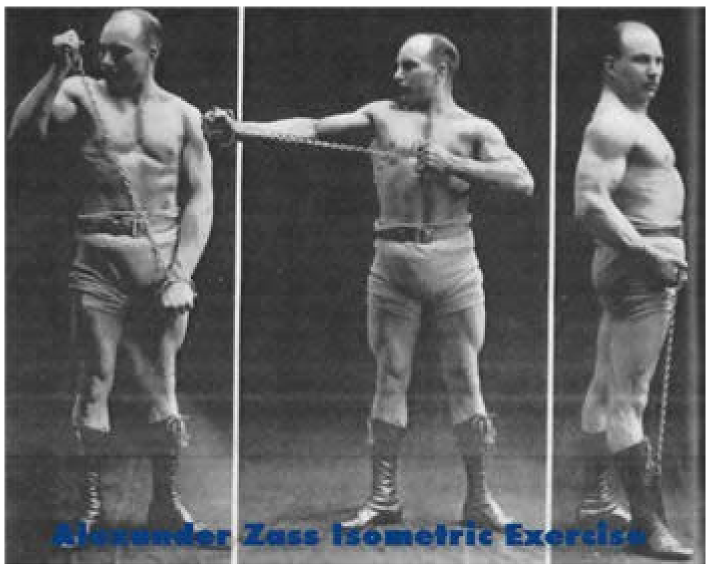
These dynamometers served for both training and the measuring of maximal strength. (A very similar and fantastic way to use the principles in this report is by using the Bully Xtreme. It combines the features of a Dynamometer, but with increased comfort and resistance.)

The Truth about Isometrics Training

For Isometric training, the subject had to contract according to a given pattern, e.g. a prescribed number of kg's: for a prescribed number of seconds. In measuring maximal strength the subject had to make one short maximal contraction. The maximal position on the scale was recorded automatically for later reading.

It is very important in dynamometric studies that the position of the subject be fixed in an exactly duplicable way for each reading in a series that may extend over months, and that the equipment be adaptable to the size of different persons.

A strong isometrics contraction is the stimulus which makes a muscle increase it mass and strength.



It makes no difference whether the contraction happens at home, at work, or is a gymnasium... whether one contracts muscles with the special aim to increase muscular strength, or just casually.

In order to determine the relationship between muscular activity and increase or decrease in strength, on should, therefore, be able to control all activities of a person.

The stimulus giving on the dynamometer is therefore not the only one responsible for the observed training. All of the other uncontrolled contractions made in the course of the day should be added.

This Cannot Be Done!

We experimented on members of our staff and on a number of students and asked them merely to avoid excessive work with the muscles that we were observing.

To get quantitative and reliable results under such conditions seems at first impossible. It will, however, become clear why the daily activities did little or nothing to disturb the results.

The threshold of muscular tension necessary to get a training effect (Hettinger and Muller) In normal life muscular strength usually holds at a constant level. This means obviously that out daily activities do not act as a training stimulus-at least not beyond that of maintaining our strength.

In the first series of experiments the subject made one single static contraction daily with each arm, the right arm at one fraction of maximal strength, and the left to another, e.g., the right arm to 1/3, the left arm to 2/3.

We call this the training strength. Once a week the maximal strength was measured, and the training strength adjusted progressively to the increasing maximal strength in order to keep the traction of 1/3, 2/3, etc.

How To Get Maximum Strength Using Isometrics Training

We found that the training stimulus need not be a contraction of maximal strength. In fact, 2/3 of maximal has the same training effect whereas 1/3 or less is not effective. The threshold lies between 3/10 and 4/10 of maximal.

It is difficult to determine the threshold with greater exactness since the lower the fraction of maximal strength that is used for training, the more it equals the strength used in daily life.

One has also to consider that the determination of the maximal strength once a week itself acts as will be shown later, as a training stimulus sufficient to increase muscular strength.

At present we can at least be sure that about 40% of the maximal strength does enough to get the quickest possible training effect.

The next series of experiments dealt with the question as to whether a longer unstained contraction, especially one sustained until complete exhaustion, would lead to a greater training speed.

This involves the question of whether or not highly anaerobic conditions and the accompanying accumulation of metabolites are a necessary accessory stimulus for the increase of muscular strength during training.

In this series we found that the increase of strength gained in the course of several weeks by one daily contraction is not influenced by the length of contraction time.

Even the shortest contraction of more than 40% of maximal strength has a maximal effect. Fatigue and exhaustion do not influence the training effect.

This has been confirmed by further experiments of Hettinger that compared the training effect of the same training strength under conditions of good and poor blood supply.

The third series of experiments pursued the question of what happens if more or less than one contraction per day is performed for training.

The intervals were varied from a fortnight down to fractions of a day.

Correspondingly, the frequency of the training stimulus ranged from one every 14 days to 7 per day. One can see that more than one contraction per day gives no better results than just one per day. Contracting a muscle less often than once a day, on the other hand, reduces the spread of increase in strength.

After an interval of 14 days no increase in strength is detectable. This is due to the course of increase and decrease of strength. Following a single contraction strength rises at the highest rate of speed during the day and then more slowly from day to day for seven days.

Thereafter in the days of the second week it drops back to its initial value. That is why after two weeks no effect is found.

Summarizing the results reported thus far... one can say that there is no better way to increase muscular strength than one short, about half-maximal, isometrics training contraction, once a day.

Contracting the muscle for a longer time, more strongly or oftener does not improve the resulting increase in strength. In ordinary practice one would not use a half-maximal but a maximal contraction.

This Has 3 Distinct Advantages

1. **One needs no dynamometer to measure the training strength . It can be exerted against any resistance at hand.**

2. The training stimulus increases progressively with the increase in strength.

3. **If a dynamometer is used each maximal training contraction is at once also a measurement of maximal strength.**

The application of these findings permits large savings in training time and apparatus.

They will permit the strengthening of muscles without burdening metabolic, respiratory and circulatory functions since a short one-second contraction does not increase these functions appreciably.

Discussion of Possible Errors

We are now able to assess the errors that could be introduced in our experiments by the training effect of uncontrolled contractions in daily life.

If a man keeps his daily activities nearly constant before and during training experiments, one can be sure that from this stimulus his maximal muscular strength has about three times the force exerted in his daily activities.

No further training stimulus is to be expected from the latter. If perchance during a training experiment force applied in daily life surpasses the normal limits, it would not influence the course of daily isometrics training with maximal strength. Since a second daily contraction does not increase the training effect.

Only if sub maximal training strength is used or if the training stimulus is not given each day could a quicker increase of strength follow from super-normal uncontrolled contraction of the subject's routine activities of daily life.

This increase would disappear in a fortnight if the surpassing stimulus were not constantly repeated.

Isometrics Cross training

Several authors have claimed that training muscles of one side of the body has a marked influence on the muscular strength of the other. (Hellebrandt, Parrish and Houtz; Slater-Hammel; Darcus and Salter).

We never observed such an effect in our experiments. Even the most marked increases in muscular strength of the trained muscle were absolutely one-sided.

What Could Be the Reason for This Striking Difference ?

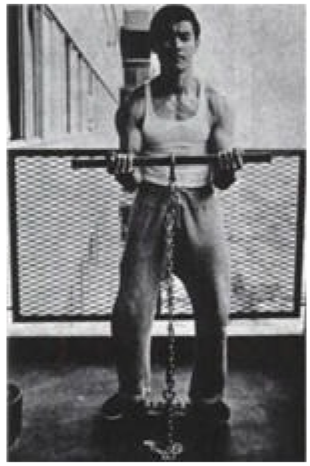
The main reason for this difference may be found in the fact that all the authors who found crossover training effects have measured strength by judging maximal dynamic work. Whereas we took a maximal status contraction as the measure of strength involves not only the strength of muscles but also the blood supply, as already mentioned.

Since, isometrics training itself was also done by long-lasting dynamic work and not, as in our case, by a single static contraction, there are good reasons to believe that the training had worked on heart and circulation as well.

An increased power of the circulation to supply muscles with blood obviously helps the muscles of both sides and even the other muscles such as the abdominal's.

There is another explanation for the reported results with cross training.

In order to compare the extremities of both sides of the body before and after training, one measures the maximal strength at the beginning and at intervals during the course of training.



If one trains only one side but controls the results on both sides, this control of maximal work is in itself a training stimulus. Before we ere able to verify this fact, we were ourselves misinterpreting our results.

A third, but probably less likely, reason might be that doing dynamic work involves a much more complicated pattern of innervations than a mere static contraction.

Different parts of muscles have to contract one after the other during shortening, with changing force adjusted to the changing resistance.

That means "nervous learning" and we know that such "nervous learning" does cross over. (Hellebrandt, Vetter and Muller).

Practical experience also does not support the cross training theory. Why should an unused limb or a lesser used limb lose strength and mass if the parallel limb has a normal or even abnormal strength as is usually the case in patients with a one-sided inactivity, e.g. in amputees?

The Threshold of Muscular Tension Necessary to Avoid Atrophy

It is well known that absolute inactivity of a muscle is followed by atrophy, i.e. a loss of mass and strength. We investigated if this loss occurs at the same rate of speed as the loss observed following the close of training period. (Muller and Hettinger)

We put one arm in plaster and kept it inactive for periods from one day to one week. This procedure should give the maximal speed of loss in strength by atrophy.

We found that the loss of strength in strict inactivity is at least four times as rapid as the loss from a trained muscle after the end of training.

Since, one cannot be sure that all static contractions inside the plaster cast are avoided, the actual speed might even be greater.

We can therefore say that the condition in an atrophic muscle are different in principle from those in a trained muscle. It is not the same state as two different levels of strength.

This is confirmed by the fact that the speed of regaining strength after a period of inactivity and atrophy is also about four times the speed of the increase in strength in training a normal muscle.

The next step was to measure the threshold of the stimulus necessary to prevent atrophy. This was done by Hettinger who made a cast of plaster for the forearm and divided it into two halves which were screwed together (Fig. 3).

The cast was opened once a day carefully avoiding any load by gravity on the flexors and extensors. The elbow joint axis was brought in a vertical position and one contraction of 1/5, 1/10, 1/20 etc. of the maximal strength was exerted. The arm was put back in the cast again.

It could be shown that a contraction equal to 1/5 of maximal strength one per day was just sufficient to prevent atrophy, 1/20 was equal to full inactivity while fractions between had a tropical effects of various speed.

Definition of Normal Strength

The stimulus of any muscular contraction has therefore two different effects: the one prevents atrophy, the other induces increase in strength.

These effects have different thresholds. The maximal effect of one is reached with a contraction of 20% of the maximal strength, the other with a contraction of 35% of the maximal strength.

Stimuli between the 20% and the 35% do not induce training yet they are sufficient to prevent atrophy. The maximal strength that we found when stimuli did not exceed these limits we designated as normal strength.

The two stimulating effects of a contraction differ according to the speed of their action as already shown. They differ also in the frequency necessary to make them effective.

We found that the isometrics training effect is secured even by one contraction per week.

The atrophy-preventing effect, however, needs more frequent contractions per week. We are now trying to determine this frequency. Finally, the atrophy-preventing effect persists in older people whereas the training effect is lost.

Further proof for the existence of a normal strength is given by the distribution curve of the strength of a group of 56 men and 58 women (Fig. 4). 80% of the men have a flexor-torque on the forearm in a right angle position in the narrow range from 5.5 to 6.7 kgs.; 80% of the women from 3.5 to 4.6 keg. There is a different maximum for each sex and practically no overlapping of the curves.

Increase of Normal Strength

We mentioned above that strength which was increased by daily isometrics training is lost in about the same time that was required to build it up. We know ,however, from experience that strength gained in youth by over-normal activity persists for life even when activity no more surpasses normal limits.

To reconcile these divergent findings the follow experiments are condensed in Fig. 5. Curve A shows the increase in strength of a person trained with daily contractions of maximal strength.

Strength is doubled in 20 weeks and lost after the end of training in 30 weeks.

In Curve B, which belongs to the same person, daily training lasted merely 11 weeks. Strength increased during this time 66% of 6% per week. Training was then continued for another 12 weeks with only one maximal static contraction per week.

The slow drop of strength following the end of training in Curve B compared with the quick fall in Curve A is very striking. To avoid any training effect from the testing for maximal strength, these measurements were taken at long intervals of several weeks.

Curve C gives the average results of an experiment where training with one maximal static contraction per week was done on 11 different muscle groups of another person.

They increased in strength 72% in 46 weeks, i.e. 1.6% per week. The fall of strength after the end of training is again very slow. 70 weeks after the end of training it is still 42% higher than before the beginning of training.

We have already established in unpublished experiments that fortnightly training after daily training maintains an increased level of muscular strength for longer than one year.

It looks like a permanent increase of the normal strength. We don't know yet the reason for this fixation of strength gained by slow training.

Isometric Training, Exercise and Nutrition

One could ask, why does not every muscle keep a constant strength big enough for the necessary activities of the individual? Why has selection developed the possibility of training?

One could try to answer these questions in the light of our results.

It seems that nature has very carefully provided for reducing muscular mass to as little as possible. This is seen in the sparing of muscle mass on children, on women, in sparing it during winter.

It is also seen in the quick drop of mass after the end of intensive daily training. Only if again and again muscles are forced to strong contractions for months does the body allow a lasting increase of muscle substance.

The only good reason for this economic principle is obviously the fact that muscles are made of protein, and need a daily intake of protein to maintain it. The 30 kgs. muscles of a normal man ask for about the same amount of meat to be eaten in a year.

The correlation between basal metabolism and biceps strength was +0,79 +0,04 in a group of 56 men and 58 women between 16 and 50 years of age.

Experiments aimed to enlighten the relation between muscular strength and protein intake have been done by Kraut and Muller, Kraut, Muller and Muller-Wecker.

The Role of Protein in Isometrics Training

Summarizing their work, one can say that the eating of plenty of meat in order to assimilate muscular substance is only necessary for a man after a long period of insufficient protein intake.

Under such conditions other organs, the big glands, the heart and the brain have first rights on the protein. They take most of the protein given after starvation, not leaving much for an increase in muscular strength.

In a state of normal and sufficient food intake with enough protein however, there is so much protein stored in the body that an increase in muscular tissue by training is possible without any protein intake over the normal rate of 1 gram per kg. per day.

Special experiments have shown that the training effect cannot be speeded up by increasing the protein intake over the normal limits under normal conditions.

As little as 0.8 rams of protein per kg. per day when only 14% is of animal origin stop any training effect (Kraut, Muller and Muller- Wecker-unpublished).

The Need for Protein In An Isometrics Training Diet

Intake of sufficient protein is therefore a necessary condition but not a stimulus necessary to prevent atrophy nor to allow training.

It is possible that besides protein other factors in nutrition influence training-e.g. vitamins. The annual variation of the training effect showing a maximum in August-September and a minimum in January is possibly due to this influence (Hettinger and Muller).

It could, however, be due as well to a more direct influence of ultraviolet radiation (Hettinger and Seidl).

Sex and Age in Isometrics Training

The strength and train ability of muscles depends on other factors. Sex and age have a marked influence, as several authors have shown. (Ufland, Schochrin).

As far as strength is concerned, the difference between sexes varies with the muscle group tested. The selection of man as the stronger, fighting individual compared with the weaker woman charged with bearing and nursing the young does not concern all muscles equally.

Ufland found a very small difference (about 20%) in the chewing muscles, where as the strength relation of men to women for the biceps group was 1:0-.5.

Women's muscles answer to training stimuli less than do those of men. Training a group of men and women changed the strength relation from 1:0.6 to about 1:0.5 in experiments of Hettinger. Whereas sex differences in strength and trainability are correlated in middle aged people, this is not the case in older people.

It is well known that strength does not drop with age, the gift however to increase strength by training is lost in the course of aging.

Static Work Training in Rehabilitation

In a few cases we trained patients with one single static contraction per day to see if our findings on normal persons were applicable in rehabilitation. (Muller and Hettinger; Hettinger).

Two patients had lost one hand. They were fitted with artificial hands (Huffer-Hand), where supination on the forearm closed the hand between thumb and forefinger. Fig. 6 shows the increase in strength following one 2/3 maximal contraction per day. Fig. 5 in its lower curve shows the increase in stump cross-section of a thigh which was trained by static contractions against a circular compressing air pressure of 100 mm., Hg.

Noack, had great success regaining strength of the abdominal muscles of women after childbirth by contracting them against a suitable resistance.

Advantages of Isometrics Training

There are several great advantages of Isometrics training compared with dynamic training in rehabilitation.

1. **Much money and time is saved.** One contraction per day or even one week can be done at home in many cases. There is no need to drive to a center to spend time there and to use the time of others.

2. **No fatigue is necessarily involved** in training muscles since one single contraction does not lead to fatigue.

3. **May prevent diseases.** In diseases where metabolic rate has to be kept low (diabetes), a muscular atrophy due to little activity can easily be presented by static training.

4. Heart and circulation are not stressed by static training. Atrophy is therefore unnecessary in hear cases.

Isometrics Training and Endurance

Hettinger and Muller found that the time which a static contraction with given strength can be held until exhaustion remains unaltered in spite of an increased maximal strength of 64% to 97%.

This means that in spite of a lower tension (strength per cross-section) blood supply is not remarkably better. One cannot deduce any knowledge on vascularization from these findings since blood supply and endurance in static work are mainly a function of the uninterrupted compression of blood vessels (Muller, Barcrof and Swan).

One should know the maximal endurance of a trained muscle for prolonged dynamic work in order to learn about the relation between improvement of increased strength and vascularization.

A better vascularization might follow other laws than the ones found improving strength.

A strong muscle, however, does not mean better performance in practice whether in sports or in daily work. Skill and an appropriate adaptation of ventilation and circulation to the increased muscular power must be acquired by other ways than by static muscular training.

Our results do not claim to cover more than one page of the book to be written about the training of all physiological functions.

In summary the benefits of isometrics training are numerous. for the individuals that do not have much time or the money to purchase expensive gym equipment isometric exercises using an isometric exerciser is a great solution.