Effects of Selected Weight Training Programs on the Development of Strength and Muscle Hypertrophy

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Abstract

This experiment was undertaken to determine the effects of a six-week progressive weight training program on the development of strength and muscle hypertrophy, using one exercise, the deep-knee bend, with varying repetitions. Thirty students were chosen by random from beginning weight lifting classes at Michigan State University. Following a two-week conditioning period the subjects were divided into three groups of ten each for the controlled training period. The programs were as follows: Group A—3 sets of 9-10 repetitions, Group B—3 sets of 5-6 repetitions, and Group C—3 sets of 2-3 repetitions. Individuals in each group handled maximum weight loads for the number of repetitions each was required to perform. The effectiveness of the program was determined by three measurements: (a) thigh girth, (b) dynamic strength as measured by one RM on the deep-knee bend, and (c) static strength as measured on the dynamometer. The results were graphically analyzed and percentages calculated. The data were also statistically treated using analysis of covariance. No significant differences were found between the three systems of training. All training procedures resulted in the improvement of static and dynamic strength.

THE STUDY WAS TO DETERMINE THE EFFECTS of selected weight training programs using varied numbers of repetitions on the development of strength and muscle hypertrophy.

Review of the literature

Through the practice of progressive resistance exercise, De Lorme and his co-workers (2) produced an increase in the circumference and strength of the arms and thighs. To build up power and muscle hypertrophy, De Lorme used a system of heavy resistance-low repetition exercise. He described power as the whole potential strength of a muscle used over a short period of time (as in weight lifting) and endurance as the ability to use a muscle against moderate or light resistance for long periods (as in bicycle riding). De Lorme recommends a system of heavy resistance-low repetition exercise to build up power and volume in muscle groups, and low resistance-high repetition exercise to develop endurance. The De Lorme technique of training is to start with a light weight for a given number of repetitions and progressively increase the load from one-quarter to one-half to three-quarters, and then to the total load.

Zinovieff (7) believes that De Lorme's technique is too fatiguing and exhausting and that too great a strain is placed on the muscles. Using a modified form of De Lorme's
system. Zinovieff developed what he called the "Oxford technique." The Oxford technique retains the principle of heavy resistance-low repetition, but reverses the De Lorme procedure by starting with the heaviest weight first and progressively decreasing the load.

McMorris and Elkins (6), in a study using both De Lorme's and the Oxford technique produced a 5.5 percent greater increase in strength than De Lorme's technique. They believe that a series of experiments is necessary before it can be concluded that these methods produce consistently different results.

MacQueen (5), in a survey among weight lifters and body builders, found that there is a distinction between the type of exercise used to develop muscular hypertrophy and that used to develop strength. In the hypertrophy program, muscle groups are usually exercised on alternate days in three or four sets of 8-10 repetitions, the weight used being the maximum that can be handled for the given number of repetitions. In the power program the initial weight is never less than the maximum that can be lifted ten times. The power program is essentially one of decreasing the number of repetitions performed with increasing resistance.

Capen (1) and Chin (2) in separate studies found that the weight-trained group made greater gains in strength than the non-trained group. However, in their studies, which consisted of 14-16 exercises performed with high repetitions (8-12), they did not compare two or three varied weight training programs.

Norbert Schenksky, former world and Olympic weight lifting champion, stated at Michigan State University's Weightlifting Clinic (March 10, 1962) that he bases his training entirely on five or six exercises of 3-5 sets of 2-4 repetitions of maximum or near maximum weight load.

In reviewing the literature concerning strength and hypertrophy, it seems that any program of dynamic weight training will increase both in varying degrees. The problem is to find the program that is most productive for a particular situation or individual.

A great deal of controversy exists among coaches and athletic trainers today as to what is the most efficient system of dynamic weight training. All desire a system of training that will produce the most rapid increase in strength and muscle hypertrophy within a limited time period. There is no general accepted routine of weight training that one can follow. It may be said that the optimum method is yet to be formulated.

A vast amount of experimental work has been done in recent years on animals by physiologists seeking to find the answer to the phenomenon of strength and muscle hypertrophy (4). Some of their findings have made it possible for dynamic weight training exercise to be applied on a scientific basis in physical medicine. Progressive dynamic weight training is now generally utilized in rehabilitation hospitals. This has evolved partly by trial and error and partly by imitating the methods weight lifters have used for many years. A great compliment was paid to weight lifting by De Lorme and Watkins (4) who pointed out that "they had supplied a rich heritage of empirical practice which has been applied to physical medicine."

It is generally thought that the repetitions and loads used on a clinical basis are inadequate for increasing strength and muscle hypertrophy needed by football players, shot putters, discus throwers, swimmers, weight lifters, and other athletes. The objective of this study is to find an efficient result-producing mode of dynamic progressive weight training, capable of developing massive muscle hypertrophy or increased strength in the shortest possible time. Such a training program would be an invaluable asset to any athlete as a pre-season conditioning routine and in correcting specific individual weaknesses.

Method

The 30 subjects were given a two week conditioning program to reduce the chance of injury and to familiarize them with the deep-knee-bend tech-
significant differences among body weights of the groups. Furthermore, since “regression on error” is not significant, there is no dependence on body weight indicated. A separate analysis of variance (Table 2) was conducted on the weight change of the three groups showing neither significant differences among groups nor significant increase or decrease within groups.

Girth (Hypertrophy of the Right Thigh): The analysis of covariance indicates that the groups were not significantly different in their girth change, but that there was an overall girth increase.

Girth measurement increased on an average of 3—6/4 during the experiment. Charts 2 and 3 reveal that a good percentage of the hypertrophy took place during the first two weeks of the experiment. The notable exception is noted on Chart 3 (middle thigh) where all groups made considerable improvement during the fourth and sixth weeks. Group B showed the greatest mean improvement, 5.2 percent in girth, Group A 4.2 percent, and Group C 3.5 percent.

Static and Dynamic Strength: Again it was found that the groups improved significantly, but that there was no significant differences among groups.

It was the intention in planning the experiment to compare static and dynamic strength results. Darcus and Salter’s work has indicated they would differ (3). However, in this experiment the statistical results are practically identical.
It can be observed in Table 3 that all groups significantly improved in static and dynamic strength. Group C recorded the greatest mean increase in static strength, 23.2 percent; Group A, 21.1 percent; and Group B, 15.5 percent. For dynamic strength there was a slight inverse relationship, with Group B showing a 26.7 percent gain; Group C, 21.3 percent; and Group A, 20.4 percent. Comparing the total mean improvement of all three groups,
approximately the same level of achievement was obtained by all. Between
the high and low groups there was a separation of only 6.7 percent for
static strength and 6.3 percent for dynamic strength. Charts 5 and 6 show
there was a constant upward movement in static and dynamic strength
throughout the testing periods. The only minor exception can be noted for
static strength where, on the last testing period, Group C showed no gain
and Group A declined slightly.

Discussion
From empirical experience the writer thought that Group C, performing
2–3 repetitions, would probably record the greatest improvement. In com-
paring the average mean increase of the groups, Group C did record the
greatest improvement in static strength, with a 23.2 percent increase. How-
ever, Group B, while recording an increase of only 15.5 percent for static
strength, led all groups in dynamic strength with a 26.7 percent increase.
There exists an inverse relationship between Groups B and C. Before any
definite statement could be made stating which number of repetitions are
best for developing strength, a longer study of from 16–18 weeks is necessary.
Since there are no significant differences apparent in the present study,
it appears that it makes little difference whether an individual trains on
three sets of 2–3, 5–6, or 9–10 repetitions.

Conclusions
1. No significant differences were found between the three systems of train-
ing.
2. All training procedures resulted in the improvement of static and dynamic
strength.

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