

SETS FOR SIZE

New research review on the number of sets for max muscle size

You know that the staff here at *JOPP* have a passion for truth in training for strength and power. This is evident by their backgrounds: our editor in chief holds a master's and doctorate in exercise science, not to mention nine national titles in four different strength sports, powerlifting world records, etc.; and the editor holds a master's degree in exercise science and a second master's degree in nutrition. Thus, our staff not only have experience in reading research, but also in performing and applying research. In Vol. V-1 of *JOPP* we described a study by our editor showing that multiple sets of weight training resulted in superior strength gains over a single set, and we showed you where the point of diminishing returns for number of sets lies. However, what is not clear is exactly what causes these greater strength gains. It could be greater adaptations in your nervous system, or greater changes in muscle size, or both. Not content with only knowing the effects of set volume on strength, our editor performed a second study of the same nature, but this time looked at the effects of set volume on muscle size.

Power Key: single sets, multiple sets, muscle growth



Being big is part of being strong. A new research review tells you how many sets you need to perform in order to maximize your muscle size.

Original Research

Krieger, J. Single vs. multiple sets of resistance exercise for muscle hypertrophy: A meta-analysis. *Journal of Strength and Conditioning Research* 24:1150-1159, 2010.

NEED POWER?

A lot of weight training studies often use very small numbers of subjects. It is common to see only 10 to 20 subjects per group, and sometimes less. However, when a researcher has a small number of subjects, it can be difficult to see statistically significant differences between groups. This is especially true with weight training since people vary dramatically in how they respond to training programs. The more variation there is between people, the more subjects a researcher will need just to see statistically significant differences (if a difference exists). This is a problem when researchers look at strength gains, but it is even more of a problem when they look at changes in muscle size. This is because changes in muscle size tend to be very small. If there are not enough subjects in a study, the results can be misleading. A researcher could erroneously claim there is no difference between two training programs when the real problem is that study did not use enough subjects to detect the difference in the first place. Most weight training studies have shown no significant differences in muscle size gains

when comparing single and multiple sets; however, it is quite possible, given these studies' small subject numbers, that these are false negative results.

One way to deal with this problem is through a meta-analysis, which means taking a large number of studies and analyzing the results

as a whole, looking for trends among the studies. *JOPP's* editor performed a meta-analysis of eight studies comparing single to multiple sets and the effects on muscle size gains. He used very similar methods to his previous meta-analysis on strength, employing highly sophisticated statistics. Some important aspects of his analysis are as follows:

- The analysis included only studies that compared single to multiple sets, while holding all other variables (like training intensity and frequency) constant. That way he could be sure that any differences in size gains were due to the number of sets.
- In combing through the results of multiple studies with multiple treatment

Our editor found that changes in muscle size were 40% greater with multiple sets compared to single sets.

groups and multiple muscle groups, a researcher has to account for all the sources of variation among these factors—that is, differences between studies,

differences between groups within each study, and differences between muscle groups within each group. *JOPP's*

editor used special statistics to account for these variations.

- Other factors that might affect muscle growth, such as gender (men often experience greater changes in muscle size than women) or training status (beginners may experience different gains than experienced trainees), were controlled as well.
- Special statistics were applied to guard against chance findings.
- He tested the strength of his results by removing one study from the analysis at a time and then rechecking the results. This allowed him to identify studies that may have disproportionately affected the results.

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JOPP editor and founder of weightology, James Krieger has been involved in the health, nutrition, and fitness field for over 10 years.

- He looked for the presence of publication bias—the tendency for studies that show significant differences to be published over studies that do not show differences.

- He looked at how varying the number of sets affected size gains, comparing set categories of 1 set, 2 to 3 sets, and 4 to 6 sets.

GET POWER!

Our editor found that changes in muscle size were 40% greater with multiple sets compared to single sets. Thus, just as with strength, you need to do multiple sets if you want to get maximum changes in muscle size. When the data were broken down by the number of sets, 2 to 3 sets resulted in greater size gains than 1 set, but no further significant benefit was found for 4 to 6 sets. However, only two of the eight studies involved 4 to 6 sets per exercise; the majority compared 1 to 3 sets. This means that there were simply not enough studies involving 4 to 6 sets to justify strong faith in the lack of differences between 4 to 6 sets and 2 to 3 sets.

When our editor examined the three

different set categories, he found a tendency for a progressive gain in muscle size as he moved up the categories. The response for 2 to 3 sets was 50% greater than the response for 1 set, while the response for 4 to 6 sets was 33% greater than for 2 to 3 sets.

This indicates that the point of diminishing returns for changes in muscle size is probably about 4 to 6 sets per exercise. These results were true for both trained and untrained subjects. The sensitivity analysis did show one study that had a small influence on the level of statistical significance, but it did not affect the magnitude of the differences between set categories. Also, there was no evidence of publication bias.

These results were very similar to our editor's previous meta-analysis findings on strength, which showed multiple sets to result in 48% greater strength gains and a point of diminishing returns around 4 to 6 sets per exercise. Thus, a good chunk of the greater strength gains that you get with

multiple sets is due to greater changes in muscle size. One limitation of this study is that the results are based on averages. So while multiple sets will be better on

average for most people, there will always be exceptions. Also, this analysis looked at sets per exercise, but there

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can be many exercises that affect a particular muscle group. However, most of the studies in the analysis only used one exercise per muscle group, so the results can be thought of in terms of sets per muscle group, as well as sets per exercise.

Overall, the results of this analysis indicate that you should do a minimum of 3 sets per exercise if you want to experience maximum changes in muscle size; 4 to 6 sets may be even better, although the data is not conclusive on that point. It does appear, however, that you will not get much benefit beyond 4 to 6 sets. What is clear is that, whether your goal is maximum strength or maximum size, multiple sets are the way to go.