Mark Zelig, Ph.D., ABPP, LLC
Diplomate in Forensic & Clinical Psychology
Alta Psychological Services, Inc.

6925 Union Park Center, Suite 550
Cottonwood Heights, Utah 84047-6527
801-273-3365

Facsimile (toll free) 866-907-2822
email: *markzelig@markzelig.com*
website www.markzelig.com

4325 Laurel St, Suite 297
Anchorage, Alaska 99508-5365
907-561-4141

Facts about Strength & Resistance Training

It's hard to find a place that has more misinformation and spreads more myths about dieting and physical conditioning that your local gym. And while the state of the science is always developing, actual science a better source of information than gym "lore." The purpose of this handout is to give you the data to consider when planning an exercise program with your physician or certified personal trainer.

The scientific study of strength conditioning uses several variables that are yardsticks to measure aspects of strength. These terms include:

Term	Definition
Volume	Total number of sets per muscle group. Thus, 4 sets of bench presses and 3 sets of decline bench presses equals 7 sets for determining *volume* since these exercises involve the same muscle group.
intensity (1 *RM*)	The maximum weight in which you can do one repetition (in acceptable form). The common metric in these studies is 1 RM – one repetition maximum.
frequency of training	The number of exercise sessions over a defined period, usually frequency per week
diminishing returns	The point where increased intensity, volume, or frequency produces less rate of improvement than lesser intensity, volume, or frequency.
negative returns	The point above diminishing returns. Increased effort becomes worse than no effort at all. Yes, if you train too much, a couch potato reaching for the remote control will make greater gains than you!

Questions and Answers

1. What is the optimal volume of strength training?

About 13 years ago several researchers advocated for low volume (i.e., 1-2 sets) training, arguing that the majority of strength gain is obtained in the first set of exercises for a given muscle group (e.g., Carpinelli & Otto, 1998, De Hoyos & Pollock, 1998). Furthermore, that doing three sets per muscle group produced no more improvement than a single set. Such a recommendation was adopted by the American College of Sports Medicine, and resulted in controversy between fitness trainers. One side argued for minimal volume (i.e, one or two sets) and the other side argued that the greater the volume, the greater the gain. Both sides of this controversy argued on the basis of personal experience, rather than scientific evidence.

In the meantime, psychological researchers had developed a technique for combining the results of multiple studies into a single tabulation. This procedure is referred to as *meta analysis*, a technique that has since been adopted by medical/drug researchers, and most recently by exercise researchers. Combining subjects from various studies into a single tabulation allows the researcher to observe trends and statistical relationships that are only apparent when a large number of subjects are considered. Meta analysis greatly helped settle the controversy.

2. Who was correct, the low or high volume advocates?

Two recent meta analyses, incorporating over 200 studies, found that both positions were wrong: The single set recommendation is overly simplistic, and higher volume was needed for optimal gains. The proponents of "more is better," were also wrong. People need to do more than one set – but not too many sets.

3. So what are the optimal number of sets, weight, and frequency?

It depends on if someone falls into one of these three categories: (1) untrained beginner, (2) trained, or (3) highly trained athlete. The following table is adapted from data in Marks et al. (2005).

	Untrained	Trained non athletes	Athletes
Optimal weight (percent of 1 RM)	60%	80%	85%
Minimum weight needed for significant improvement (that is, the percent weight of 1 RM)	40%	70%	70%
Weight at which negative returns occur (i.e., you get weaker than if you lift more weight)	75%	85%	unknown
Optimal training frequency (days per week).	3	2[1]	2[2]
Percent strength improvement with one set	50	50	25
Optimal sets per muscle group. Exceed this number and you make little improvement, and with even more sets you become weaker than not exercising at all.	4	4	8

4. Based on the above table, what do all three categories have in common?

Regardless of category, the optimal is always less than 1RM! All categories had a point where if they lifted too much weight or did too many sets, they would not obtain the gains that those who exercised less were experiencing. And all categories benefitted somewhat from only doing 1 set per workout.

5. Does the pooled data of 200 studies also apply to those to "train to failure"?

These meta analyses compared people who trained to failure (i.e., where they couldn't do another repetition) versus those who stopped before failure occurred. The people who trained to failure attained only 50% of the improvement of those who stopped before failure.

[1] 3 days per week results in less strength than 2 days per week

[2] 3 days per week offers no improvement over 2 days per week

6. **I have been doing weight training for 18 months. How come my progress is slowing down, making it much harder to graduate to higher weights?**

Beginners make more rapid gains that trained athletes, and this is probably because much of the increase in strength is due to neural adaptations that result in enhanced motor unit activation, rather than increased size of muscle (Marks et al. 2005, p. 952). This conclusion is supported by research that finds during the first year of training, the percentage of strength is greater than the percentage of muscle growth. After the first year, strength is more closely related to increases in muscle mass. Hence, most people's progress is slower than when they first began. Also, the more advanced one becomes, the greater need for variation in the training program to promote continued improvement.

References

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