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Can drop set training enhance muscle growth?

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Abstract

Some researchers have postulated that training to muscular failure is obligatory for maximizing muscle hypertrophy. This has to the speculation that drop set training may be an effective strategy to more fully fatigue the musculature and, in turn, enhance muscular adaptations. Herein we review the evidence on the topic.

Some researchers have postulated that training to concentric muscular failure is obligatory for maximizing exercise-induced muscle hypertrophy (20). Muscular failure can be operationally defined as “the point during a resistance exercise set when the muscles can no longer produce sufficient force to control a given load” (20). Hypothetically, taking sets to failure should engage the full spectrum of high-threshold motor units (20), which have been shown to have the greatest hypertrophic potential (1).

However, muscles are not completely fatigued at the point of concentric muscular failure as they are still capable of producing force at lower loads. Therefore, some have speculated that drop sets (also known as descending sets or breakdown sets), may be an effective strategy to more fully fatigue the musculature and, in turn, enhance muscular adaptations (15). Drop sets are carried out by taking a set to muscular failure at a given magnitude of load, and then immediately reducing the load and performing as many additional reps as possible. Generally, loads are reduced by 20-25% in drop set training (2-4), although there are no defined guidelines in this regard and thus many possibilities exist with respect to practical implementation. Conceivably, this technique may heighten muscular growth by inducing greater motor unit fatigue (20). Moreover, the increased time under load (TUL) associated with drop sets elevates metabolic stress and ischemia (6), which have been implicated as mechanisms that drive the hypertrophic response (16). Multiple drop sets can be performed to induce even greater levels of fatigue and metabolic stress, and hence potentially further enhance anabolism.

Initial research into drop sets focused on their potential to alter the post-exercise hormonal environment. Goto et al. (6) showed that the inclusion of a low-intensity set (50% of 1 repetition maximum [RM]) immediately following performance of 5 high-intensity sets of leg extensions at 90% 1 RM produced a significantly greater acute growth hormone spike compared to the protocol performed without a drop set. While spiking growth hormone levels has been touted by some as a prominent driver of muscle growth, recent research calls into question the hypertrophic benefits of elevated post-exercise hormonal levels (18). Thus, the practical applications of these results are unfounded concerning muscular development.

Follow-up work by the same lab sought to provide insight into the long-term effects of drop sets on muscular adaptations (7). Recreationally trained men were recruited to perform a 2 day-per-week hypertrophy-type resistance training program for 6 weeks consisting of 3 sets of the leg press and leg extension. In this initial phase, all participants showed an approximately 4% increase in muscle cross sectional area (CSA) of the thigh as determined by magnetic resonance imaging (MRI). The subjects were then randomized to perform either a basic strength-type routine (5 sets at 90% 1RM) or the same routine with the inclusion of a lower load drop set. After an additional 4 weeks of training in this manner, the drop set group experienced a ~2% increase in CSA of the thigh. In contrast, the group performing the strength-type training routine showed a ~0.5% decrease in thigh CSA. A limitation of the study was that it did not control for total training volume. Given that there is a well-documented dose-response relationship between resistance training volume and muscle hypertrophy (19), this leaves open the possibility that the greater muscle protein accretion associated with the performance of drop sets was caused by an associated increase in training volume as opposed to any direct mechanistic benefit of drop set training.

Fisher et al. (4) sought to assess body composition changes from drop sets by randomizing resistance-trained individuals to one of three different conditions: (i) a group that performed a single set of 8-12 RM, (ii) a group that performed the same single-set routine with a drop set carried out using a 30% reduction of the initial training load, and (iii) a group that performed the routine at 4 RM then performed a double drop set with load decrements of 20% on successive series. Training was carried out twice weekly for 12 weeks. Although exercises targeting all the major muscle groups were included in each session, drop sets were only performed for the lateral pulldown, chest press, and leg press. Results showed no significant differences between conditions in changes in fat-free mass despite a greater volume performed by the drop set group. While the findings would seem to indicate no benefit to the use of drop sets, it should be noted that measurement of fat-free mass was assessed by air displacement plethysmography (i.e. BodPod), which is not specific to skeletal muscle as it includes all non-fat components (i.e. bone, body water, etc.). Moreover, nutritional status was not monitored, further confounding results.

Several studies have investigated the effects of drop sets on hypertrophy compared to traditional training while attempting to equate for the volume of training between groups. Employing a within-subject design, Angleri et al. (2) compared the hypertrophic response of a lower-body drop set protocol to a traditional resistance training protocol in resistance-trained men with conditions equalized to total training volume (sets × repetitions × load). Training was carried out using the leg press and leg extension exercise at 75% of 1 RM for 12 weeks. One leg performed the 3-5 sets of the routine in a traditional fashion with 2 minutes rest between sets whereas the contralateral leg performed the same routine while employing up to 2 drop sets using sequential decrements in load of 20% 1RM. B-mode ultrasound testing showed that both the drop set and traditional training groups significantly increased quadriceps CSA (7.8% and 7.6%, respectively), with no differences found between groups. However, when using such a design, possible cross education effects also cannot be disregarded; albeit, this seems more relevant from a muscular strength than a hypertrophy standpoint (12).

In a study specific to upper body exercise, Fink et al. (3) randomized 16 recreationally trained young men to perform triceps pushdowns using either a single 12 RM set with 3 consecutive reductions in the load of 20% or a traditional resistance training protocol consisting of 3 sets of 12 RM with 90 seconds rest between sets. Training was carried out twice per week for 6 weeks under volume equated conditions. Muscle CSA as assessed by MRI was virtually double that when employing drop sets compared to a traditional straight-set protocol (10.0% vs. 5.1%). Although the findings did not reach statistical significance (possibly due to the low statistical power of the study), effects size differences favored the drop set group (effect size difference of 0.26), suggesting a modest but, from a practical standpoint, potentially meaningful hypertrophic benefit for drop set training.

More recently, Ozaki et al. (14) compared drop set training to resistance training protocols involving differing intensities of load. Untrained men participated in a within-subject design whereby their arms were randomly assigned to perform elbow flexion exercise with either heavy-load resistance training with a 3-minute rest interval (80% 1 RM), light-load resistance training with a 90 second rest interval (30% 1 RM) or a single set at 80% 1 RM followed by 4 drop sets at 65%, 50%, 40% and 30% 1 RM. Total training volume was significantly greater in the light load condition versus the drop set and heavy load conditions. MRI showed that elbow flexor CSA increased similarly in all groups over the 8-week study period.

Individuals commonly report a lack of time as a barrier to participating in resistance training (8). In this regard, drop sets might be of great value as both Okazaki et al. (14), and Fink et al. (3) reported that the groups that used drop-sets reduced their training time by more than half compared to the group that trained with traditional resistance training methods. These findings indicate that robust gains in muscle mass can be achieved with limited training time by incorporating drop set training into program design.

Practical Applications

Drop sets present an intriguing strategy to enhance resistance training-induced muscular gains as the combination of higher muscle activation and increased metabolic stress provide a sound rationale to enhance anabolism via a diverse array of mechanistic factors (17). However, the current literature is equivocal as to whether drop set training provides an additive hypertrophic benefit to performing traditional resistance training with straight sets, at least when total training volume is equated between conditions. Moreover, the studies to date have considerable heterogeneity in their designs and the training status of subjects. Thus, more research is needed in this area to draw more definitive conclusions as to the relevance of drop set use for muscle growth.

It can be hypothesized that drop sets may confer hypertrophic benefits by preferentially stimulating the growth of type I muscle fibers. The slow-twitch nature of these fibers makes them “endurance-oriented” resulting in a higher fatigue threshold. Greater TUL might be necessary to induce a hypertrophy response in type I muscle fibers, as studies that used resistance training programs with very short set durations report no hypertrophy in these fibers (10). In contrast, studies that employ a training program with a greater TUL report substantial type I muscle fiber hypertrophy (11, 13). Hence, the greater TUL provided during drop set training would plausibly stimulate these fibers to a greater degree than traditional training alone. Whether such fiber type specific adaptations actually occur in practice during drop set training and, if so, how this phenomenon might affect whole muscle hypertrophy over time remains to be determined.

Drop sets would seem to be most appropriate when included in the hypertrophy or muscular endurance phase of a periodized program. It is clear that drop sets provide an effective means to increase training volume without substantially increasing the duration of a workout. Given the well-established dose-response relationship between resistance training volume and hypertrophy (19), this has important implications for maximizing the hypertrophic response. Adding a drop set or double drop set to the last set of an exercise for a given muscle group is a feasible strategy for accomplishing this goal while keeping total session duration shorter compared to simply employing additional straight sets. Moreover, substituting traditional sets with drop sets on a volume-equated basis substantially reduces total resistance training duration of a given session without compromising muscle growth. Thus, drop sets can be considered a viable training approach for those with limited time to exercise. Table 1 summarizes recommendations for training variables when using drop-set training.

*****Insert Table 1 about here*****

The continuous use of drop sets may be detrimental over time. Chronic hormonal alterations have been associated with repeatedly training to muscular failure, including decreases in resting levels of insulin-like growth factor-1 and an attenuation of testosterone concentrations (9). These outcomes have been hypothesized to increase the potential for overtraining and psychological burnout (5), which in turn may impair hypertrophic adaptations. Given that drop sets are highly taxing to the neuromuscular system from repeated bouts of training to muscular failure, persistent, excessive use would conceivably heighten the risk of overtraining. The threshold for the use of drop sets invariably will be specific to the individual and programming must take into account both genetic and environmental factors.

Table 1. Drop-set recommendations for muscular hypertrophy

Training variable	**Recommendation**
Load	Load is commonly reduced by 20-25% with each drop (e.g. a 10RM squat at 120 kg would be reduced by 24 to 30 kg after achieving failure at the target load). Larger or smaller drops in load can also be employed. Large reductions, such as 60-70% would probably make it difficult to maximize peripheral fatigue. In contrast, smaller reductions in load, such as 5-10% will reduce the total amount of repetitions that can be performed.
Rest intervals	The rest interval should be minimal, just enough time to reduce the load and position the exerciser into the starting position for the next set.
Training volume	Most commonly, one, two or three drops in load are employed. It remains unclear if there is any benefit to using more than three drops in load.
Tempo	Both slower and faster tempos can be used (1 to 3 seconds on the concentric and eccentric actions). It needs to be considered that very slow tempos (>4 seconds) will significantly reduce the number of repetitions that can be performed and thus,

	reduce the total volume load.
Exercise selection	Both multi-joint and single-joint exercise can be used; however, from a practical perspective, single-joint exercises are preferred, especially for individuals training without a training partner/personal trainer.
Frequency	Drop set technique can be used multiple times throughout a training week; however, it might be that a continuous use of this technique can potentiate overtraining.

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