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EFFECT OF SINGLE- AND THREE-SET TRAINING VOLUMES ON LOWER BODY STRENGTH AND POWER IN UNTRAINED INDIVIDUALS AFTER A 3-WEEK PERIOD

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ABSTRACT

The purpose of this study is to identify and compare the effect of a 1- and 3- set deadlift training program on lower body strength and leg power. Forty-two (N = 42) untrained female college subjects (Mean Age = 14.60) were assigned to either 1 or 3 set training program. Comparisons were done through tests with level of significance at p = 0.05. When a significant difference was found, effect size was then assessed using Cohen's d. There was a significant difference in the 1 RM and Leg Power (Standing Long Jump) for the 1 set group as well as for the 3 set group. Since the training duration was only for three weeks, results might have been primarily due to neural adaptations rather than muscle hypertrophy. The data suggests that either one or three sets can produce small improvements in strength even as early as three weeks of training. Further investigation is needed to determine when the dose-response volume to training will begin to be more observable.
Keywords: *Single-set training, three-set training, lower body strength, untrained.*

1. INTRODUCTION

The deadlift, one of the three events in powerlifting, is a multi-joint exercise which involves lifting a resistance or load off the ground, creating triple extension of the ankle, knee, and hips (Schellenberg, Lindorfer, Renate, Taylor, & Silvio, 2013; Berglund, Aasa, Hellqvist, Michaelson, & Aasa, 2015; Blanchard, Berning, Adams, & DeBeliso, 2016). Similar to the squats, the deadlift strengthens the quadriceps, hamstrings, and the erector muscle groups (Escamilla, Francisco,

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Kayes, Speer, & Moorman, 2011; Camara, Coburn, Dunnick, Brown, Galpin, & Costa, 2016) This form of exercise has been utilized by strength coaches because it allows for a heavier load, in contrast with other free weights exercises, hence resulting in greater strength gains which contributes to enhanced power output (Zatsiorsky, 1995).

Various modifications of this exercise have been utilized for different objectives. One of the more common variations that was used in this experiment is the sumo stance deadlift. This method differs slightly from the conventional version by assuming a wider stance, while the hands are positioned in between the thighs, as opposed to outside (Piper & Waller, 2001). The sumo variation was previously found to be less stressful on the lumbar spine, which might be a sound alternative for performance enhancement or rehabilitation (Cholewicki, McGill, & Norman, 1991).

Resistance training has been documented to improve muscle strength, which may lead to improved power (Kraemer, Ratamess, & French, 2002). Studies have looked into the relationship between squats and leg power, particularly vertical jumps (Baker, 1996; Mangus, Takahashi, Mercer, Holcomb, McWhorter, & Sanchez, 2006; McWhorter & Sanchez, 2006), while one study documented the acute effects of heavy deadlifts (85% of 1 RM) to vertical jump (Arias, Coburn, Brown, & Galpin, 2016; Hamilton, Berning, Sevene, Adams, & DeBeliso, 2016; Springall, Larson, DeBeliso, 2016). To this author's knowledge, none has investigated the effect of deadlift and leg power, specifically its transfer to performance, utilizing the standing long jump (SLJ). Findings by Castro-Piñero, Ortega, Artero, Girela-Rejón, Maria, Mora, Sjöström, and Ruiz, (2010) stated that the SLJ might be a useful tool as it was found to be strongly associated with common lower-body muscular strength tests (Farrell, Adams, & DeBeliso, 2016).

Since the deadlift utilizes the same muscle groups as in jumping, this paper aims to look at the effects of the sumo deadlift on SLJ performance. To the author's knowledge, no paper using a single- and a three- set deadlift-only protocol, performed twice a week for three weeks, has compared their effects on leg power.

Numerous studies have suggested the advantage of multiple-set training over single sets, in eliciting strength gains (Rhea, Alvar, Ball, & Burkett, 2002; Kelly, Brown, Coburn, Zinder, Gardner, & Nguyen, 2007). For untrained individuals, Rønnestad, Egeland, Kvamme, Refsnes, Kadi and Raastad (2007) recommended an 11-week, 3-set training regimen for the lower-body, to optimize strength and hypertrophy gains. The traditional guideline for training frequency suggests at least three workouts a week, with the days in between serving as rest periods (Fleck & Kraemer, 2014). Considering that the above-mentioned

guideline was made for athletes, beginners or the untrained population can work out for a minimum of two days per week.

Regardless of the frequency of training, it has been documented that volume defines strength gains. Moritani and DeVries (1979) was perhaps the first to investigate the time course of strength gain and hypertrophy. Their study utilized isotonic strength training in a span of eight weeks using a total of 15 subjects (7 male, 8 female). Their findings suggest that initial increase in strength were due to neural adaptations. Hypertrophy contribution to strength was a factor during the third to fifth week of training. Moreover, short-term studies on training volume were done with a training frequency of 4 weeks or more (Stowers, McMillan, Scala, Davis, Wilson, & Stone, 1983; Wescott, 1986; McGee, Jessie, Stone, & Blessing, 1992; Schlumberger, Stec, & Schmidtbleicher, 2001). Hence, this paper aims to investigate the time course of strength and power enhancement of a deadlift-only, three-week training program, composed of twice a week workout sessions.

2. METHODS AND MATERIALS

2.1 Research Design

This is a pre-test, post-test study which identified the effects of a single and triple-set lower-body resistance training program on 1RM (strength) and SLJ (power). The program had a three-week frequency, consisting of twice-a-week deadlift training. The sumo stance deadlift variation was used, with the subjects utilizing the alternate grip.

2.2 Participants

A total of forty-two (N=42) untrained female college students, with mean age 14.6 + 0.8 years, participated in a three-week deadlift program. The subjects were divided into two groups, with twenty-one subjects assigned each to the single- and triple-set protocol.

2.3 Procedure

Prior to the start of the program, practice sessions for the deadlift and the standing long jump were held for two days, separated by a one day rest interval. This was to negate any acute learning effects. The deadlift practice involved executing the movement pattern utilizing only their body weight for ten repetitions. The second set involved using a 10-pound bar for the same number of repetitions.

A separate day was allotted for the familiarization of standing long jump. The subjects first practiced executing basic countermovement squat jumps for two sets of six to eight repetitions to familiarize them with landing, with each set separated by 30 seconds of rest. Two minutes separated the last squat jump set and the start of the standing long jump sets. The same volume and inter-set rest interval were done for the standing long jump practice.

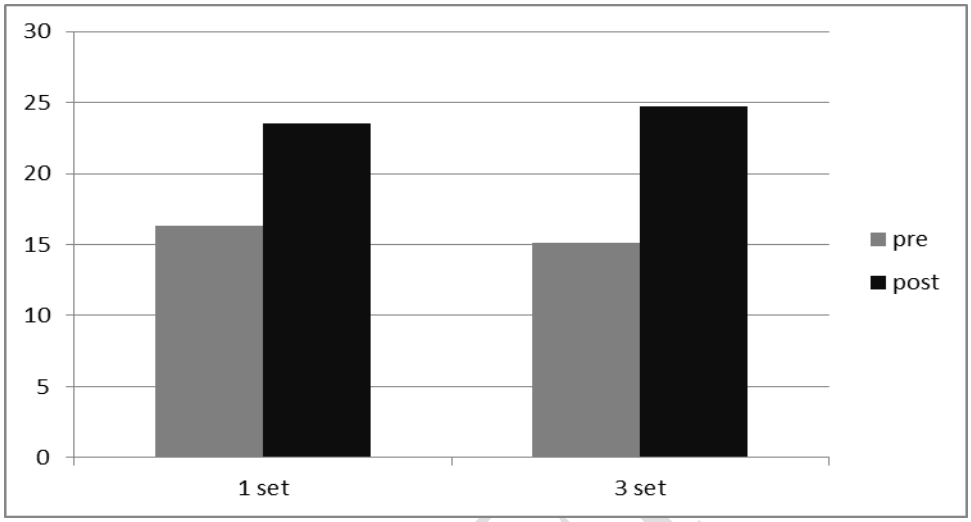
For the SLJ, the subjects performed three trials each, separated by three minutes of rest intervals. The best of the three trials was recorded. Estimation for the 1 RM of the deadlift was also done in a separate day. For the standing long jump pre-test, the single set group started for the first hour followed by the triple-set group. Each group had two subjects performing the pre-test simultaneously. The subjects jumped for three trials, each separated by three -minutes rest intervals. Distance was calculated via the difference between the starting heel position and the landing heel position of the rearmost landing foot (Contreras, Schoenfeld, Beardsley, McMaster, Reyneke, & Cronin, 2017), using a tape measure. The best (farthest) of the three trials was recorded in centimeters. Prior to the deadlift protocol, the subjects performed a set of dynamic warm-ups (1 set of 8 repetitions) which consisted of knee hugs, leg cradles, inverted hamstrings, split squats, hand-walks, sumo squat-to hamstring stretch. The dynamic warm up was followed by one set of ten jumping jacks and 1 set of five-second high knees in place.

The program proper had the single-set group perform one set of six repetitions per day, separated by one day rest interval, twice a week. The other group performed three sets of six repetitions, with each set separated by two minute rest, for two separate days. Load assignment was based on their pre-test lifts, while for load progression, all the subjects increased their lifts by 2.5 percent every week.

3. RESULTS

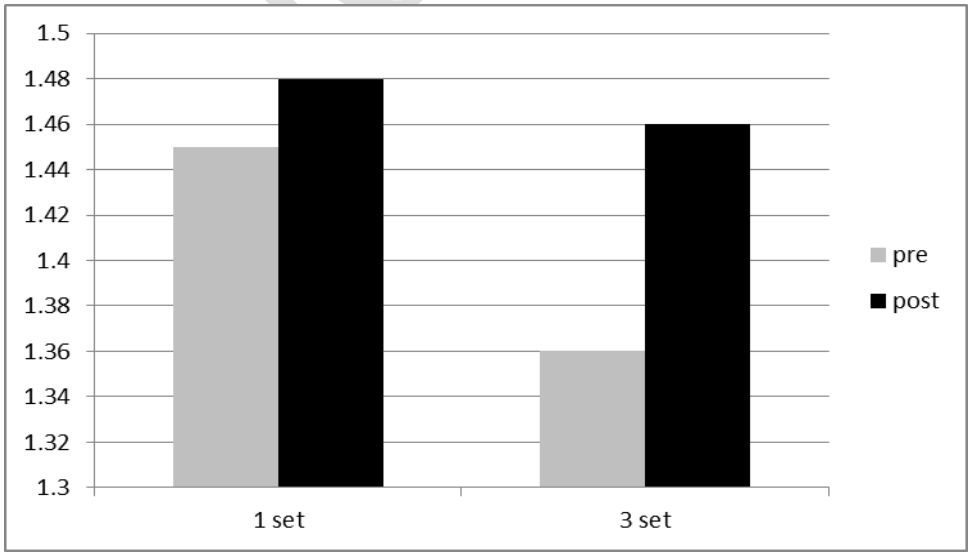
The Single set group started with an average of 16.3kg for the pre-test and a significant increase of 23.5kg for the post-test. The three-set group started with an average of 15.1 kg and a post-test of 24.7kg and yielded a significant increase of 9.2kg. The differences within each group was statistically significant with a large effect for the single set group (d= 0.882) and the 3-set group (d=1.532). A summary of the 1 RM results is presented in Figure 1.

Figure 1: Pre-test and post-test 1RM deadlift of 1-set and 3-set group in kilograms



In terms of leg power, the increase was small but significant both for the single set group (from 1.45cm to 1.48cm) and 3-set group (from 1.36 to 1.46), with a small effect (d=0 .154 and 0.384 respectively). A summary of the SLJ scores is illustrated in Figure 2.

Figure 2. Pre-test and post-test of standing long jump, in centimeters



4. DISCUSSION

Results revealed significant improvements for the 1RM deadlift of both the single- and three- set groups. The principle of training specificity may have elicited the improvements in strength, even for a relatively shorter training frequency. The said improvement may have been attributed to neural adaptations related to acute learning, since muscle gains was said to only occur after a much longer time frame (Chilibeck, Calder, Sale, & Webber, 1998; Lloyd & Faigenbaum, 2016). Further research for dose-response relationship may be warranted.

As for the standing long jump, both single and three-set programs had small but significant improvements. The deadlift creates a simultaneous activation of the knee extensors, knee flexors, hip extensors, and the lower back musculature (Thompson, Stock, Shields, & Luera, 2015), which is the same group of muscles utilized when generally executing a jump. Although there is a slight difference biomechanically, the standing long jump may have improved due to the increased activation of the hip extensors. According to Swinton Stewart, Keogh, Agouris, and Lloyd (2011) increasing deadlift load makes the movement more hip dominant, which may have enhanced neural adaptations. In the same light, there is a high force production throughout the long range of motion in the deadlift. The high force production, combined with acceleration needed in this lift may explain the development in muscular power (Swinton *et al*., 2011).

Based on the findings, it can be highlighted that training volume might be of more importance than training frequency, when it comes to strength improvements. Frequency of training is just one variable which can be modified to increase or decrease training volume (Fleck & Kraemer, 2014). Candow and Burke (2007) found out that the same total volume, regardless of the distribution of sets and frequency, yielded no significant difference in 1 RM of back squats or bench press. They concluded that adjustments in volume will bring about maximal gains in strength.

Stock, Olinghouse, Drusch, Mota, Hernandez, Akalonu, and Thompson, (2015) found that there were also muscular adaptations as early as eight resistance training sessions, spread over four weeks. In this study, improvements can be attributed to neural adaptations, even only after six sessions, in a span of three weeks. Although the difference in improvements is negligible, this author recommends a one-set lower-body training which involves one exercise for untrained individuals, for the initial phase of the program. It is also similar to the recommendations of Wolfe, Lemura, and Cole, (2004). While Rønnestad *et al*. (2010) suggests a 3:1 set ratio of lower body to upper body training initially for

novice subjects, the single set protocol might be a good option if time constraint is a concern (Kriger, 2009).

Trends in this study suggest that with an extended training duration, greater improvements may be observed in strength and power, favoring multiple set training, in agreement with the aforementioned studies (Rhea *et al*., 2002; Kelly *et al*., 2007; Kriger, 2009)

5. CONCLUSIONS

Furthermore, based on the subject's reactions and impressions, the researcher observed that they still had the energy to do extra sets of the deadlift or other exercises beyond what was prescribed in the program. This means that, even as beginners, they could have done more thereby increasing the training stimulus and possibly producing greater performance increases. It may be advised to do further research on this aspect within the context of training volume.

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