

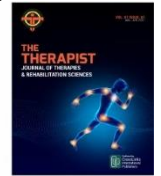


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Original Article

## Effects of German Volume Training on Muscle Strength and Muscle Hypertrophy

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### ABSTRACT

Strength training is a kind of practice intended to enhance muscle strength and hypertrophy. **Objective:** To measure the effect of resistance training on muscle strength and hypertrophy between two groups, group A (05 sets) vs. group B (10 sets) over a period of 14 weeks of training. **Methods:** The data was collected from gym goers at The University of Lahore, aged between 18-25 years and had experience of resistance training at a recreational level for one year. Twenty trained athletes were incorporated and purposive sampling was used in this study. The training intervention was conducted over three sessions in a week with one day of transition period for proper recovery from fatigue due to high intensity training. Session one consisted of chest and upper back exercises, session two consisted of leg exercises, and session three contained arms and shoulder exercises. The baseline characteristics of both groups were assessed at the initial stage, including age, height, and total body mass, and after training, the paired-samples t-test was used to assess the mean difference between both groups. **Results:** The mean difference for paired-samples t-test for anterior thigh muscle thickness of group A was -1.900 while group B had -4.900. Similarly, in strength, the mean difference for paired-samples test for 1RM leg press of group A was -39.600 whereas group B had -29.800. The results showed that group A gained significant muscle hypertrophy and strength as compared to group B. **Conclusion:** It was found that 5 sets on each muscle group in a week with three workout sessions showed better results in order to enhance muscle hypertrophy and strength.

### INTRODUCTION

Strength training is a kind of practice intended to enhance muscle strength and hypertrophy [1]. Volume may be one of the main elements affecting the efficiency of muscular strength and hypertrophy resistance training [2]. The entire number and load employed for a certain exercise of the repetitions (set x repetitions) is defined as the volume of resistance exercise. Previous studies of the effect on adaptations of a muscular resistance training size were carried out by checking for parameters which affect intensity and modifying simply the set done [3,4]. Untrained individuals should execute fewer sets than advanced exercising trainers (one to three sets vs. three to six sets respectively) according to current strength training standards for muscle strength and Hypertrophy [5]. These concepts increase muscular strength and size by raising the volume of sets per exercise to six as training expertise rises.

Three systematic reviews & meta-analyzed information on muscle strength and hypertrophy effects of a certain quantity was amazing [2,6,7] found that 2–3 sets can generate an increase of 40% over a single set per workout in the strength of muscles and hypertrophy. In addition, the dosage response associated with enhanced muscle strength and muscle growth rose with the increasing number of sets to around four to six sets, which were followed by no additional advantages. These findings indicate the suggested set of guidelines for advanced trainers [5]. In addition, the effect of a total amount of sets per week by muscle group was investigated and a more suitable indicator of the amount of training examined [2].

Mechanical stimuli stimulate skeletal protein synthesis, and lifting bigger loads increase the reaction until a plateau is reached [8]. Notwithstanding findings of a limit of muscle strength and increased hypertrophy beyond four to six sets [6,7],



the top limit for sets is still unknown. It has been suggested to generate extensive metabolic load and mechanical stress, resulting in larger depletion of the substrates, metabolite build-up and muscle damage, due to a large volume of resistance training [9]. These elements, in combination with sufficient rehabilitation after exercise, will encourage anabolic responses leading to increased muscular growth [10] and strength [11,12]. Strength training at volumes over a "top limit" may however in general be adverse for force-related tasks and can mute or disable the hypertrophic response [13].

German Volume Training (GVT) is a strategy utilized to enhance muscular mass of their sportive athletes during the off-season by national weightlifting trainers [14]. Two compound resistance workouts with 60% 1RM or 20RM loads comprise of 10 sets of 10 repeats (i.e., Hundred repetitions) [15]. The recovery process between sets is comparatively short (~60–90s) to increase metabolism stress, in addition to the high training volume (e.g., construction of lactate metabolites). For the 6 weeks, the efficacy of a modified version of GVT (ten sets technique) has been compared to the higher part of the set range that the resistance trainers frequently utilize (five sets). Simply put, the change to the standard GVT programme involved helpful exercises after two workouts for ten sets. Also previously GVT employed squats and deadlifts, but have been substituted for leg press and lungs. In the prior trial, no greater improvements in muscular hypertrophy were observed following a modified version of GVT during a six-week period compared to five sets [16].

Five sets of research showed that the upper body strength increased in five set, which was different from the few researches that studied the influence on muscle strength of an identical number of sets [16]. After six weeks of press training in bench presses in a programme that examined 8 sets with 12 sets, did nothing to identify differences in bench press maximum (1RM) [17]. In the case of four sets to 8, following a six-week squat training programme, no discrepancies were found in squat 1RM however squat 1RM increased considerably for eight set compared with one Squat [18]. Due to the very short study time (i.e., six weeks). It was not clear whether the results were influenced by this together with the other research above. For example, it has been decided that a muscle resistance and hypertrophy resistance training framework should last for at least 10–12 weeks with three to five sessions a week [19]. As a conclusion, effective execution over a lengthy period of time of a broader sample of a modified GVT (i.e. ten set technique) programme on muscle strength and muscle hypertrophy is not recognised [20].

The goal of the present research was to assess the effects on muscle strength and hypertrophy of a 14-week training programme using five sets of exercises against 10. In each training session altered only the sets of the first two exercises, while the sets were constant for each of the remaining exercises in both groups. In order to separate the effects of greater sets on results measures, both groups received the same beginning loads for each workout.

## METHODS

The experimental methodology for this study was employed to detect the effects on muscle strength and muscle hypertrophy of 10 sets versus 5 sets of strength training sessions with 3 sessions every week. The entire study was carried out in The University of Lahore gym between two groups of healthy male having at least 12 month experience of RT at recreational level. The study was conducted over a 14-week period to examine the effects on muscular growth and strength of ten set versus 05 set of resistance training and athletes must have been doing resistance training for at least the last three months. To carry out this study, twenty voluntarily trained athletes of resistance training were incorporated. To find out the sample size purposive sampling was used. With the assistance of an experienced and certified radiologist, an ultrasound technique was used to measure muscle hypertrophy as well as body composition was determined using Dual Energy X-ray Absorptiometry (DXA), and muscle strength was determined by comparing 1 Repetition Maximum (1RM) at the beginning and end of the study.

The training intervention was conducted between group A (5 sets) and group B (10 sets) through three session in a week with one day of transition period for proper recovery from fatigue due to high intensity training; in session one chest and upper back exercises were performed (Flat Bench Press, Lat-Pulldown, Incline Bench Press, Seated Row and crunches); session two consisted of legs exercises whereas session three contained of arms and shoulder exercises. The main difference of between both groups was number of sets for first two compound exercises of each session, for example; group A performed 5 set and group B performed 10 sets for bench press and leg press for 10 reps of each exercise at load of 60-80% of 1RM with rest period of 60-90 seconds between sets. Exercises of calf raisers and abdominal exercises were same for both groups (Sets × Reps).

Twenty healthy athletes with resistance training experience were assigned either 5 set groups of exercises or 10 set groups of exercises by dividing them into two groups of ten participants each. All necessary measurements of athletes, including height, weight, and age, were taken prior to the start of the study. All exercises were repeated 10 times at 60–80% of 1RM, with 60–90s rest between sets. If the participants did not finish 10 repetitions of an exercise with a certain load, they were urged to complete till failure. As a result, if participants did not complete 10 repetitions, the weight lifted during sessions

were not decreased. Participants were instructed to perform repetitions until momentary failure on the final set of all exercises (i.e., unable to generate sufficient strength to complete the repetition and lift the load). All repetitions were carried out under managed way (i.e., 1 second approximation of concentric contraction and 2 second approximation of eccentric contraction) during all sets. The training load was increased by 5–10% when participants could complete more than 10 repetitions of the set (with accurate technique). The increase in training loads was influenced by the exercise, with larger increases in load for exercises involving larger muscle groups than for exercises involving smaller muscle groups.

Body composition was measured using a whole-body dual energy x-ray absorptiometry scanner. A radiologist performed the scans under standardised conditions (early morning, overnight fast, and standardised body positioning on the scanning bed). Maximum strength for the horizontal leg press and flat barbell bench press was assessed using the one-repetition maximum (1RM) test.

Participants did not conduct a practise other than day-to-day life activities at least 48 hours before a 1RM test. Before evaluating 1RM, there was a particular warm-up that included a set of 5 repetitions at 50% of the perceived 1RM, followed by one–two sets of two–three repetitions with a load equivalent to 60–80 percent of 1RM. The 1RM procedure includes testing of a single repetition of increased stress (5–10% increases), with a time interval of 3–5 minutes. This cycle was continued until the athlete couldn't finish the lift, the 1RM was successfully hoisted to signify the biggest load. The barbell near the chest was lowered and then the bar was lifted until the elbows were practically straight. The test was successful. In addition, the athletes had to display little back arching and swinging for a good 1RM bench press. Being flexed at around 90 degrees, the participants begin the leg press. The hips and knees were stretched till almost straight and they returned to the first position. This is a successful 1RM leg press attempt.

To conduct all the analysis, software SPSS Version 23 was employed. The baseline of the 5-Set and 10-Set sample for 14 weeks were compared with pairs t-tested, such as body composition and muscle strength and muscle exercise variables (percentage 1RM). An analysis of the paired-samples t-test was done to examine the impacts on body weight, body fat percentage, total body lean mass, leg, trunk, and arms as well as strength effects of training protocols (10-SET vs. 05-SET) (1RM bench press and leg press). Data in mean  $\pm$  standard deviations are displayed (SD). The significance level has been determined at  $p < 0.05$ .

## RESULTS

Table 1 presents that in Group A,  $t(9) = -189.776$ ,  $p < 1.5931E-17$  and the pre mean  $\pm$  deviation value of group A before training was  $48.50 \pm 2.73$  mm and after training post mean  $\pm$  deviation was  $53.40 \pm 2.72$  mm ( $p < 1.5931E-17$ ); with thickness difference of  $4.90 \pm 0.08$  mm. In Group B  $t(9) = -21.243$ ,  $p < 5.3322E-9$  and the pre mean  $\pm$  deviation value of group B before training was  $50.20 \pm 3.24$  mm and after training post mean  $\pm$  deviation was  $50.10 \pm 3.06$  mm ( $p < 5.3322E-9$ ), with thickness difference of  $1.90 \pm 0.30$  mm. So, due to means of both groups we can conclude that both groups gained thickness but there was very significant increase in anterior thigh thickness of group A as compared to group B for the same period of training.

	Paired Differences					t	df	Sig. (2-tailed)
	Mean	Std. Deviation	Std. Error Mean	95% Confidence Interval of the Difference				
				Lower	Upper			
Anterior thigh muscle thickness of Group A (pre) (mm) - Anterior thigh muscle thickness of Group A (post) (mm)	-4.900	.081	.025	-4.958	4.841	-189.776	9	.000
Anterior thigh muscle thickness of Group B (pre) (mm) - Anterior thigh muscle thickness of Group B (post) (mm)	-1.900	.282	.089	-2.102	1.697	-21.243	9	.000

**Table 1:** Paired-samples test for anterior thigh muscle thickness of group A and group B

	Paired Differences					t	df	Sig. (2-tailed)
	Mean	SD	SE Mean	95% Confidence Interval of the Difference				
				Lower	Upper			
Bicep muscle thickness of Group A (pre) (mm) - Bicep muscle thickness of Group A (post) (mm)	-4.700	.4422	.139	-5.016	-4.383	-33.610	9	.000
Bicep muscle thickness of Group B (pre) (mm) - Bicep muscle thickness of Group B (post) (mm)	-.600	.08165	.025	-.658	-.541	-23.238	9	.000

**Table 2:** Paired-samples test for briceps muscle thickness of group A and group B

Table 2 presents that in Group A,  $t(9) = -33.610$ ,  $p < 9.0075E-11$  and the pre mean  $\pm$  deviation value of group A before training was  $31.20 \pm 0.03$  mm and after training post mean  $\pm$  deviation was  $35.90 \pm 2.83$  mm ( $p < 9.0075E-11$ ); with thickness difference of  $4.70 \pm 0.44$  mm. In Group B  $t(9) = -23.238$ ,  $p < 2.4084E-9$  and the pre mean  $\pm$  deviation value of group B before training was  $32.50 \pm 2.63$  mm and after training post mean  $\pm$  deviation was  $33.10 \pm 2.67$  mm ( $p < 2.4084E-9$ ), with thickness difference of  $0.60 \pm 0.08$  mm. So, due to means of both groups we can conclude that both groups gained thickness but there was very significant increase in biceps muscle thickness of group A as compared to group B for the same period of training.

	Paired Differences					t	df	Sig. (2-tailed)
	Mean	SD	SE Mean	95% Confidence Interval of the Difference				
				Lower	Upper			
1RM Leg Press of Group A (pre) (Kg) - 1RM Leg Press of Group A (post) (Kg)	-39.600	3.204	1.013	-41.892	-37.307	-39.082	9	.000
1RM Leg Press of Group B (pre) (Kg) - 1RM Leg Press of Group B (post) (Kg)	-29.800	1.398	.442	-30.800	-28.799	-67.388	9	.000

**Table 3:** Paired-samples test for 1RM leg press of group A and group B

Table 3 presents that in Group A,  $t(9) = -39.082$ ,  $p < 2.3367E-11$  and the pre mean  $\pm$  deviation value of group A before training was  $64.20 \pm 6.77$  kg and after training post mean  $\pm$  deviation was  $103.80 \pm 5.22$  kg ( $p < 2.3367E-11$ ); with an increase in 1RM of  $39.60 \pm 3.20$  kg. In Group B  $t(9) = -67.388$ ,  $p < 1.7625E-13$  and the pre mean  $\pm$  deviation value of group B before training was  $65.40 \pm 5.91$  kg and after training post mean  $\pm$  deviation was  $95.20 \pm 6.14$  kg ( $p < 1.7625E-13$ ), with an increase in 1RM of  $29.80 \pm 1.40$  kg. So, due to means of both groups we can conclude that both groups gained an increase in 1RM but there was very significant increase in 1RM of group A as compared to group B for the same period of training.

	Paired Differences					t	df	Sig. (2-tailed)
	Mean	SD	SE Mean	95% Confidence Interval of the Difference				
				Lower	Upper			
1RM Lat Pull down of Group A (pre) (Kg) - 1RM Lat Pull down of Group A (post) (Kg)	-8.800	2.299	.727	-10.445	-7.154	-12.100	9	.000
1RM Lat Pull down of Group B (pre) (Kg) - 1RM Lat Pull down of Group B (post) (Kg)	-4.300	.253	.080	-4.481	-4.118	-53.564	9	.000

**Table 4:** Paired-samples test for 1RM Lat pull-down of group A and group B

Tables 4 presents that in Group A,  $t(9) = -12.100$ ,  $p < 7.172E-7$  and the pre mean  $\pm$  deviation value of group A before training was  $58.60 \pm 3.77$  kg and after training post mean  $\pm$  deviation was  $67.40 \pm 4.88$  kg ( $p < 7.172E-7$ ); with an increase in 1RM of  $8.80 \pm 2.30$  kg. In Group B  $t(9) = -53.564$ ,  $p < 1.3849E-12$  and the pre mean  $\pm$  deviation value of group B before training was  $54.40 \pm 3.91$  kg and after training post mean  $\pm$  deviation was  $58.30 \pm 3.95$  kg ( $p < 1.3849E-12$ ), with an increase in

1RM of  $4.30 \pm 0.25$  kg. So, due to means of both groups we can conclude that both groups gained an increase in 1RM but there was very significant increase in 1RM of group A as compared to group B for the same period of training.

## DISCUSSION

In this study, the effect of the 14-week GVT (10 sets approach) modified programme was examined for muscular hypertrophy and strength training in comparison to 05 set training that is usually applied for resistance training. Results showed that in the 10-Set training was less effective in terms of muscle hypertrophy while the 5-Set training group relatively increased muscle hypertrophy. In the light of the results, the statement that 10 set training program would increase muscle hypertrophy was refuted. The lean mass of group A (05 sets) demonstrated increased in comparison with group B. There was also a difference in muscle strength across post-test groups, group A favoured more than group B in muscle strength, vividly supporting the second hypothesis of the study. In particular, no significant difference between the two groups was identified in the 1RM bench press, whereas in 1RM leg press, there was an increase in group A, whereas in 1RM lat pull-down also favoured group A. In group B, 1RM muscular strength was also increased in both leg press and lat pull-down but this difference was not significant compared to group A.

The results of 14 week modified GVT in bigger cohorts were recommended to be verified [20]. The duration of the amended GVT program was therefore be extended to at least 12–14 weeks to allow notable muscle adaptations [19]. Conversely to our original premise, each exercise of group B (10 sets) over a 14 weeks period was not shown to lead to increased muscle growth compared to group A. The exercises of group B (10 sets) were much higher than the group A (5 sets), which should emphasize muscular hypertrophy-impacted elements (e.g., mechanical tension, metabolic stress, muscle damage) [9]. Findings that Group B (10 sets) is not helpful to enhance muscle mass in comparison with group A (5 sets), for example, can recommend a higher muscle growth training volume range from 5 to 10 sets. This threshold could be closer to group A, as the [7,8] observation is restricted by the increase in the amount of training over 4 to 6 sets per workout.

The research revealed that the increase in lean body mass and fat rate was very small in group B after 14 weeks of training as compared to group A, as the reduction in lean weight was detected by [20] for group 10-SET during weeks 7 to 12. However, external factors have altered for these participants, such as levels of physical activity or dietary behaviors that was not observed or recorded. Although the supervised sessions asked all participants not to do any resistance training, further any advice on other exercises was not offered.

Furthermore, Group B favored 1RM bench press, the difference was extremely minor compared to Group A but it was not easy to grasp, whereas this response was opposed to 1RM leg press and produced substantial outcomes in group A. Marshall and colleagues in 2011 showed that the 1RM squat was larger in eight sets than in one set [18]. Nevertheless, the 1RM squat split for four sets compared to eight sets was not different from the other sets, which shows that gains of strength from greater than 4 sets are limited. The benefit of 10 sets is also minor when compared to 5 sets for leg training, according to our observations.

## CONCLUSIONS

The goal of this study was to compare the effect of resistance training on muscle strength and hypertrophy in two groups: group A (05 sets) vs. group B (10 sets) over a 14-week training period. The subjects of the study were experienced male athletes, who had experience of resistance training. In the light of empirical evidence, it was observed that the effects of resistance training on muscle hypertrophy is ineffective more than five sets as group A showed significant results in comparison of group B, while in muscle strength group A had excellent increase in strength as compared to group B. The difference in results of both groups can be attributed to training volume, intensity, caloric intake and rest period. The results could also be different for the reason that other physical activities that were not considered in this study and all participants were advised to refrain from any strength exercise except exercises of study. Furthermore, the nutritional aspect of the phenomena was not addressed throughout the study and the results demonstrate difference that could significantly differ from the present study. So, future research can directed at studying nutritional effects of diet for profound and more dynamic results. Future research study could be conducted on athletes by monitoring the diet plan, keeping in mind difference of training intensity. Furthermore, another interesting avenue for future research could be to study the effect of psychological profiling, counseling and guidance to the gym goes and those undertaking GVT.

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