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Comparing the effects of ten weeks of equipped vs. non-equipped training on performance in collegiate powerlifters

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COMPARING THE EFFECTS OF TEN WEEKS OF EQUIPPED VS. NON-EQUIPPED TRAINING ON PERFORMANCE IN COLLEGIATE POWERLIFTERS

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ABSTRACT

Advances in powerlifting equipment have enabled athletes in that sport to achieve lifts once thought impossible. The effect of training using specialized powerlifting gear on performance has not yet been studied. PURPOSE: To examine the effects of powerlifting equipment on performance measures before and after 10 weeks of training. It was hypothesized that equipped lifters would achieve higher total training volumes and greater performance gains in the squat, bench press, and deadlift. METHODS: Eighteen powerlifters between the ages of 18 and 26 were randomized into either a group that trained and competed in equipment (Eq), or trained and competed without equipment (Non). Before and after the program changes in training volume, volume progression, and handgrip and vertical jump, and performance were assessed. RESULTS: Training volume increased significantly in the first 4 weeks for both groups. During this phase, volume lifted for the squat and the totals was slightly greater in the Eq. There were no differences in handgrip and vertical jump after training in either group. There was a significant increase in squat (↑19.05±30.97lbs, $p=0.02$), dead lift (↑19.05±21.17lbs, $p=0.001$) and the Total score (↑44.00±60.44lbs, $p=0.005$) for both groups combined. The improvements in the squat (Eq= 33.85 vs. Non= 5.74, $p=0.07$), and the totals (Eq= 66.59 vs. Non= 23.67, $p=0.15$) were more meaningful in the Eq. Both groups showed a significant and similar increase in the Wilks scores (+13.54 points, $p=0.03$). CONCLUSIONS: There was a trend towards greater volume progression in Eq during the first four weeks of training. However, training volume and progression, handgrip and vertical jump were not statistically different between groups. Both groups significantly improved performance for the squat, and deadlift, and had higher totals, and Wilks scores, indicating significant strength gains. The greater magnitude of improvements in the squat and totals for the Eq lifters suggests a potential for a meaningful competitive advantage when training with specialized powerlifting gear.

INTRODUCTION

Powerlifting is a sport in which the goal is to lift as much weight as possible for one repetition in three different lifts: the squat, bench press, and deadlift. At a competition, the lifter gets three attempts at each lift, beginning with the squat, moving on to bench press, and ending with the deadlift for a total of nine max attempts. The highest number posted for each lift is added together for a lifters total, and the lifter with the highest total wins the competition in their respective weight class. Powerlifters are widely regarded as the world's strongest pound for pound athletes, and their training methods and exercises are used in almost every strength and conditioning program in the world. Because of the effectiveness as tools in gaining strength and muscle mass, variations of the powerlifts are generally staples in most recreational exercisers programs as well. Also, the functional aspect of the lifts (especially the squat and deadlift) makes them extremely useful tools in the elderly and also rehabilitation settings.

The sport of powerlifting became popular in the late 1960's, and since that time advances in training methodologies and general training knowledge have led to dramatic increases in current world records for the three lifts, as well as a higher overall average of weights lifted at national and world competitions. In addition to advances in this training knowledge, the advancement of equipment used in training and competition, specifically the squat suit, bench press shirt, deadlift suit, and knee wraps have contributed as well. The squat and deadlift suits are made from a thick polyester material that covers the hips, upper legs, abdominals, and lower back and is held up by straps that are placed over the shoulders. When worn during the squat, the suit acts as a harness that tightens as the lifter descends through the eccentric phase, decreasing the resistance of the load and assisting the lifter in pushing the weight through the concentric phase to the top position of the lift. Knee wraps, which are also worn during the squat in

conjunction with the squat suit, are long pieces (1-3 meters) of stretchy material that are wrapped tightly around the lifters knees and provide additional rebound out of the bottom position of the lift. A bench press shirt is worn during the bench press and is made from similar material as the squat and deadlift suits. The bench press shirt is worn like a regular t-shirt, but because of the extremely stiff material, provides the lifter with a rebound effect from the chest to about midway through the lift, at which point the assistance diminishes and the lifter must complete the lift by fully extending the elbows. Originally, the equipment was designed to protect the lifter and reduce joint injuries (especially of the shoulder and knee) by helping to compress the tendons and ligaments in these joints, increasing pressure within the joint and shifting the force of the load from the joint to the equipment being worn.

Advances in material and suit design by equipment manufacturers over the years have caused the emphasis of the their products to be less on safety and more towards performance enhancement, with the result being athletes lifting with the equipment are able to handle much larger loads in training and in competition than without it. The amount of weight that an athlete can lift with the equipment as opposed to without it depends on variables such as; tightness of the equipment, type and the number of layers of material used to make the equipment, experience level of the lifter, and individual strengths and weaknesses of the lifter. For example, since the bench shirt assists the lifter off of the chest (where there is a great amount of pectoral and anterior deltoid activation) and ceases to assist midway through the lift, the lifter must have strong triceps to complete the lift with the heavier load. Tightness of the equipment is also a major factor in how much carryover a lifter will receive with the gear, with tighter gear allowing the lifter to handle much heavier loads than looser gear.

Study Purpose

Like all athletes, powerlifters practice in the equipment that they will use in the competition. An average training cycle will last 8-12 weeks, with 3-4 workouts per week lasting anywhere from 1.5 to 3 hours per workout. If the lifter chooses to wear the equipment in the competition, he will devote a large portion of his training time wearing that equipment. As stated earlier, modern suits and bench press shirts are made of thick material that is very tight and constrictive when worn properly, and lifters often spend hours in the suits with their legs and arms in a constricted state. Research has shown that restricting blood flow while performing resistance training is beneficial for promoting gains in strength and muscle mass that are greater than non-occluded training (Loenneke et.al 2010; Yasuda et al. 2011; Meyer 2006; Abe et al. 2010). This type of training is also referred to as KAATSU, which was made popular by Japanese researcher Y.Sato. Sato studied this technique for over 40 years, applying it to himself for injury recovery and recreational bodybuilding as well as clinical populations to increase strength and muscle mass (Sato 2005). KAATSU training is characterized by performing low intensity cardiovascular or resistance training while moderately occluding blood flow to the working muscles with bands or blood pressure cuffs. Although the exact cause of these adaptations is unknown, one theory is that an accumulation of metabolic waste products inside the occluded muscle may stimulate subsequent increases in anabolic growth factors such as growth hormone, IGF-1, and testosterone. Additionally, these metabolites may inhibit myostatin expression, and potentiate a higher recruitment of fast myosin (Loenneke et al. 2005). Increases in growth hormone in response to KAATSU training are seen regularly in the research, but the exact mechanism or metabolite responsible for these increases has yet to be identified. From these results, it may be that the intramuscular environment that occurs with low intensity

occlusion training is similar to that experienced during non-occluded, high intensity training. Recently, it has been demonstrated under strict lab conditions the degree of blood flow occlusion that occurs in those wearing competition powerlifting equipment is significant, therefore the use of the equipment in a powerlifting style training program could be classified as a form of blood flow occlusion training.

The focus of blood flow occlusion studies has thus far been on the combination of KAATSU training methods with low training intensities. Abe et al. performed a study that utilized low intensity KAATSU walk training on a senior population (60-78 years) and found that muscular strength and size was increased above the control group during a six week period (Abe et al. 2010). This study coincides with other research, including work by Y.Sato that demonstrates its potential application to clinical populations in improving functionality. These studies have focused primarily on elderly or injured populations who cannot work at high intensities, and the results of high intensity occlusion training on strength gains has not been examined. Moreover, there is currently no research on the effects of restrictive powerlifting equipment on strength gains in recreational or competitive strength athletes engaged in regular, high intensity training. This question is particularly important to competitive powerlifters who could apply this knowledge to their training by better calculating the optimal training volume performed while using competition equipment in order to see the largest performance gains. It is hypothesized that lifters who train and compete in equipment will be able to train with higher volumes than those training without equipment. Also, it is hypothesized that the higher volumes achieved by the equipped lifters will lead to greater increases in powerlifting performance gains of the squat, bench press, deadlift, and total. The purpose of this study is to compare differences in performance gains between powerlifters who are either training in and competing in restrictive

equipment, and those training and competing without the equipment. Additionally, the arterial stiffness of the athletes as measured by pulse wave velocity and the augmentation index will be examined. The effects of resistance training on arterial stiffness is hotly debated in the literature, with many studies concluding that the strength training has a stiffening effect on the arteries, although the chronic cardiovascular adaptations of such training is poorly researched (Miyachi et al. 2004; Yoon et al. 2010; Collier et al. 2008).

METHODOLOGY

Study Participants

The main inclusion criteria for the participants were competitive powerlifters currently training for the "Southern Showdown: ULL vs. LSU" powerlifting competition that took place on the last day of the intervention. All volunteers were recruited from the LSU Powerlifting Club and varied in gender, bodyweight, and experience level. Upon agreeing to take part in the study, lifters were either placed into a group that trained and competed in equipment (Eq), or a group that trained and competed without equipment (Non). In total, there were 18 participants in the study, with 10 in the non- equipped group and 8 in the equipped group.

Experimental Design

The study was a randomized, prospective design comparing performance outcomes, as well as basic strength and power measurements between groups of equipped and non- equipped powerlifters. The experimental procedures consisted of a 10 week strength training intervention, as well as basic strength and power measures. The lab testing procedures were conducted over the course of two visits, pre and post intervention. Body composition was assessed first, followed by basic strength and power tests.

Experimental Procedures

- **Hemodynamic Variables**

Prior to the onset of training blood pressure, heart rate, and vascular stiffness were obtained. Prior to obtaining the hemodynamic measurements, participants were instructed to lie quietly in a supine position for 10 minutes. Subsequently, resting blood pressure was obtained

using a Littmann stethoscope and blood pressure cuff, and resting heart rates were also taken at this time.

Radial artery applanation tonometry and pulse wave analysis were used to calculate derived central blood pressures and central stiffness parameters .To capture pulse wave velocity, sequential measurements of arterial pressure waves at the carotid and femoral arteries were made. The surface distances from the suprasternal notch to the carotid and femoral sites were measured (Sphygmocor CPV system training). Pressure wave transit times to each site were measured using the foot-of-the-wave method:

$$PWV = \frac{\text{Distance (ss notch to femoral – ss notch to carotid)}}{\text{Time (ekg to femoral – ekg to carotid)}}$$

- **Performance Measurements**

Upon being assigned to either the equipped or non- equipped group, a simulated meet was conducted by the LSU Powerlifting coaches one week prior to the beginning of the intervention to gather 1RM's in the Squat, Bench Press, and Deadlift. As in a competition, lifting began at a set time and all attempts were judged according to standards set forth in the USA Powerlifting federation rulebook. Also, lifters performed the lifts in the same order as in a competition; beginning with three attempts in the Squat, then three attempts in the Bench Press, and ending with three attempts in the Deadlift. For the Squat, the lifter takes the bar out of the rack, stands fully erect with hips and knees locked and back straight, and waits for the head judge to give a "squat" command. The lifter must then descend with the weight until the hip joint is below the knee joint, then ascend until fully erect and wait for the head judge to give a "rack" command before walking the weight back into the rack. For the Bench Press, the lifter receives the bar from a spotter, holds at arm's length with elbows locked out and no bar movement, and

waits for a "start" command from the head judge. Upon receiving the command, the lifter brings the bar down to the chest and pauses until the bar is motionless and receives a "press" command from the head judge, then press the bar up to arm's length. Once the elbows are fully locked and the bar is motionless, the lifter receives a "rack" command and the bar is placed back into the rack. The Deadlift is the last lift of the meet and involves the lifter simply picking up a loaded barbell from the floor to a fully erect standing position, with hips, knees, and elbows locked out (U.S.A. Powerlifting). For the Deadlift, the lifter may choose a conventional style with a narrow stance and hands outside of the legs, or the sumo style with a wide stance and hands inside of the legs. The athlete was given three attempts at each lift, and was only given credit for the lift if it was executed according to the standards set forth in the USA powerlifting handbook. The highest successful attempt at each event was added together to get the total, which was recorded as the athletes performance pre measure as well as the highest successful individual attempts at each lift.

At the end of the 10 week training intervention, all lifters participated in the "Southern Showdown: ULL vs. LSU" Powerlifting competition in Lafayette, Louisiana. The individual lifts that were passed as good lifts in competition, as well as the athletes total were counted as performance post measures in the study.

- **General Strength and Power Measures**

To assess general strength and power measures, a series of basic fitness tests were conducted in the lab including body composition, hand grip strength, and a vertical leap test. Body composition was assessed using skin fold calipers and the Jackson Pollock three site skinfold test to obtain body density. To estimate body fat, from the body density, the Siri

equation was used. The three sites used for males were the chest, abdominal, and thigh. For females, the sites included the triceps, suprailiac, and thigh. Hand grip strength was obtained using a hand grip dynamometer (Baseline Hydraulic Hand Dynamometer by Fabrication Enterprises Inc.). The dynamometer was held straight out at arm‘s length and the subject squeezed as hard as possible for several seconds and the highest value obtained was recorded. Each participant performed three trials with each hand. Next, a vertical leap test was conducted to assess lower body power using a Vertec vertical jump measuring device (Vertec by Power Systems Inc.) After the measuring tool was calibrated to the participant, he or she stood directly underneath the device and jumped as high as they could, touching the tallest possible vane. Each participant was given three vertical jump attempts.

- **Wilks Coefficient**

The Wilks Coefficient is a formula developed by Robert Wilkes of Australia that is used at powerlifting competitions to compare lifters of different body weights. Each lifter has a coefficient based on their body weight in either kilograms or pounds, which is then multiplied by his or her total to get a figure that is compared to other lifters in the meet to establish the best lifter in the competition. In competitions held in the United States, this figure is usually then divided by 2.2046 to get the lifters final score. Although the actual formula is kept by its creator, the coefficient for each bodyweight is listed in a table on the International Powerlifting Federations’ website (International Powerlifting Federation- IPF).

Intervention

The intervention consisted of a 10 week powerlifting style training cycle that was developed to improve performance in the Squat, Bench Press, and Deadlift. This program was

the same one used by the LSU Powerlifting team in preparation for the 2010 USA Powerlifting Collegiate National Championships, in which they secured their second consecutive first place team finish. The training cycle was influenced by previously developed programs by Dr. Frederick Hatfield, who is a multi-world IPF powerlifting champion and first man to officially squat over 1,000lbs in a powerlifting competition, as well as highly regarded Russian Powerlifting coach Boris Sheiko.

The lifts of Squat and Bench Press were performed twice per week, with heavy Squats on Sunday along with a light Bench Press. Deadlifts were done once per week on Tuesday, and heavy Bench Press with a light Squat was performed on Thursday. The intensity of training (percentage of 1RM) was increased in a staggered progression, and started with 80% of max for all competition exercises during the first four weeks of training. At week 5, the intensity was increased to 85% for two weeks before being increased to 90-95% during weeks 7 and 8. The lifters began to taper at week 9 by dropping the intensity to 85%, then down to 80% of the 1RM the first day of the tenth week. During the rest of week 10, training intensity was dropped to 70% to allow the lifter to taper for the competition. Training intensity is shown in shown in figure 1.1

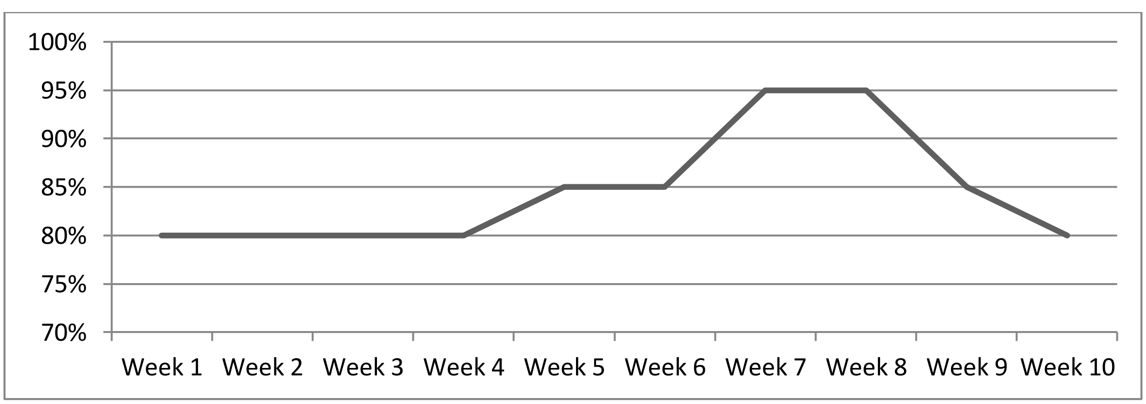

Figure 1.1 Overview of training intensities throughout the intervention.

Although the intensity followed a staggered linear progression model, the training volume (sets x reps x weight) followed a wave pattern of progression. During the first week, training volume began as five sets of 2 for heavy Squats and Bench Press, and five sets of 1 on the deadlift. During the next three weeks, volume was increased by adding one rep to each set per week, while maintaining the set number. Week 4 was the apex of volume, with 5 sets of 5 on the Squat and Bench Press, and 5 sets of 4 on the deadlift. At week five, the volume was lowered by decreasing the set number to 4 and rep number to 2, and increased the next week to 4 sets of 3. At week 7, the volume was again lowered, this time by dropping the sets to 3, and reps to 1. At week nine, 3 sets of 2 reps were performed, which coincided with the highest intensity weeks of the training cycle. On Sunday of week 10, the volume was increased again to accommodate the tapering of intensity on that day only, and lowered along with the intensity the rest of the week to allow for the lifter to recover for the competition. The training volume progression is shown in figure 1.2 below.

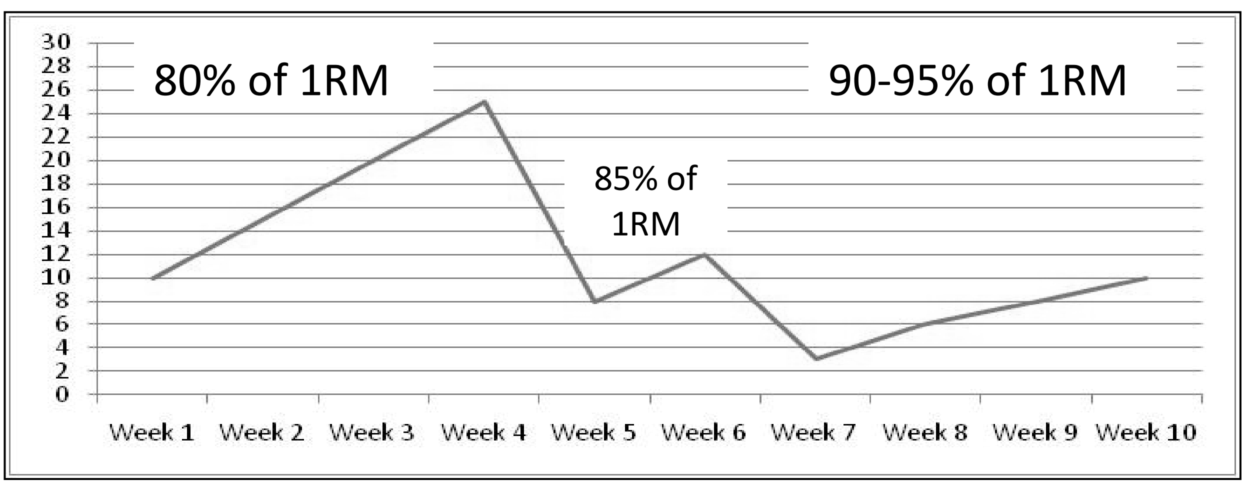

Figure 1.2 Overview of reps * sets throughout the intervention.

The program followed the physiological principle of specificity, with the majority of the training consisting of the competition lifts. The equipped group performed all work sets of 80%

or greater wearing competition gear, while the unequipped group was only allowed to wear a weight belt on work sets. Even though the equipped group performed all of their work sets with equipment, they performed auxiliary work such as the light Bench Press on Sunday and the light Squat on Bench Press day sans equipment. Also, other auxiliary exercises were performed unequipped on each training day in addition to the competition lifts that were meant to compliment the heavy lift of that day. For example, heavy Squat was performed on Sunday, followed by light Bench Press, then a different squatting exercise to build additional strength in the legs. On Tuesday, the lifters competition style Deadlift was performed as the main exercise, followed by a different style Deadlift as a compliment to the main lift. On Thursday, after heavy Bench Press and light Squat, a second type of Bench Press was performed to further strengthen the upper body pressing muscles. These auxiliary exercises were performed at a much lower intensity and slightly higher reps than the competition lift, and done without equipment in both groups.

Statistical Analysis

Statistical analyses were performed using SPSS (18.0). Group values are expressed as mean ± SD. Pre-training group differences were examined using independent t-tests. Differences in training volume across the 10 weeks were examined using a 2 (Equipped and Non-Equipped groups) * 10 (wks. of training) analysis of variance with repeated measures. The influence of training on performance and general strength and power measures was examined using two separate multivariate analyses (MANOVA). Alpha was set a priori at 0.05.

RESULTS

Participant Characteristics

Eighteen adults (14 men and 4 women) between the ages of 18 and 26 participated in this study. The equipped (Eq) group consisted of 6 men and 2 women, and the unequipped (Non) group consisted of 8 men and 2 women. Participant characteristics are presented in table 3.1a and b. On average, the lifters in the equipped group were heavier than those in the non-equipped group (Eq=198.34±49.64 lbs. and Non=170.9±42.56 lbs.; p=0.23), but the difference did not reach statistical significance. The non-equipped group had a slightly lower body fat percentage than the equipped (Eq=19.36±11.38 %, and Non=14.02±4.66 %) With body composition taken into account, the non-equipped lifters had a similar LBM as the equipped (Eq=150.42±22.88 lbs., and Non=158.6±33.09 lbs.), but averaged one weight class lower (Eq=195±43.44 lbs. vs. Non=171±44.76 lbs.).

No differences were detected between the groups in terms of hemodynamic variables (Eq= [sbp] 121± 12.37; and [dbp] 69±8.08 mmHg, and Non= [sbp] 117±12.47; and [dbp] 67±5.59, p>0.05. No group differences in HR (Eq=77±7.37, and Non=72±13.89 bpm, p>0.05), PWV (Eq= 7.07 ± .49, and Non=7.48 ± 1.17cm/s, p>0.05), or aortic stiffness as measured by the augmentation index (Eq=3.25± 8.10, and Non=3.90±8.85, p>0.05) were detected.

Training Volume

Figures 3.1-3.4 show the progression of total volume per lift during the 10 week intervention. There was a significant increase in the volume of weight lifted for each exercise during the base preparation phase for both groups. During this phase, the volume lifted for the squat and the totals showed a slightly greater volume increase in the equipped group. The

difference in the Totals was in large due to the greater change in volume lifted during the squat exercise.

Table 3.1a - Participant Characteristics

	Group	Minimum	Maximum	Mean	SD
Age (yrs)	**Eq**	18	26	21	2.45
	Non	19	24	22	2.28
Height (In)	**Eq**	65	74	69.71	3.04
	Non	62	76	68.30	5.06
Weight (lb)	**Eq**	138	277	198.34	49.64
	Non	118	238	170.90	39.21
Weight Class (lb)	**Eq**	132	275	195	43.44
	Non	114	242	171	44.76
Body fat (%)	**Eq**	10.95	39	19.36	11.38
	Non	6.33	18.74	14.02	4.66
LBM (lbs)	**Eq**	112	167.65	150.42	22.88
	Non	108.65	197.33	158.6	33.09

Table 3.1b - Participant Characteristics

	Group	Minimum	Maximum	Mean	SD
SBP rest (mmHg)	**Eq**	100	138	121	12.37
	Non	104	130	117	12.47
DBP rest (mmHg)	**Eq**	58	80	69	8.08
	Non	60	78	67	5.59
HR rest (BPM)	**Eq**	60	88	77	7.37
	Non	54	102	72	13.89
PWV (cm/sec)	**Eq**	6.7	7.8	7.07	0.49
	Non	6.4	10.2	7.48	1.17
Augmentation Index	**Eq**	-9	12	3.25	8.10
	Non	-8	15	3.90	8.85

Following the base preparation phase, the progression of volume lifted for all exercises was quite similar between groups, for the remainder of the training cycle.

General Strength and Power Measures

Table 3.2 contains the general strength and power measurements before and after the 10 week intervention. The average of three handgrip trials for strength is shown, as well as the greatest height achieved during three vertical jump trials. All participants improved slightly on the handgrip test. The improvement of the left and right handgrip strength combined yielded an increase of 5.53±13.00 kg (p=0.17). There were no significant changes in general strength and power measures between the groups.

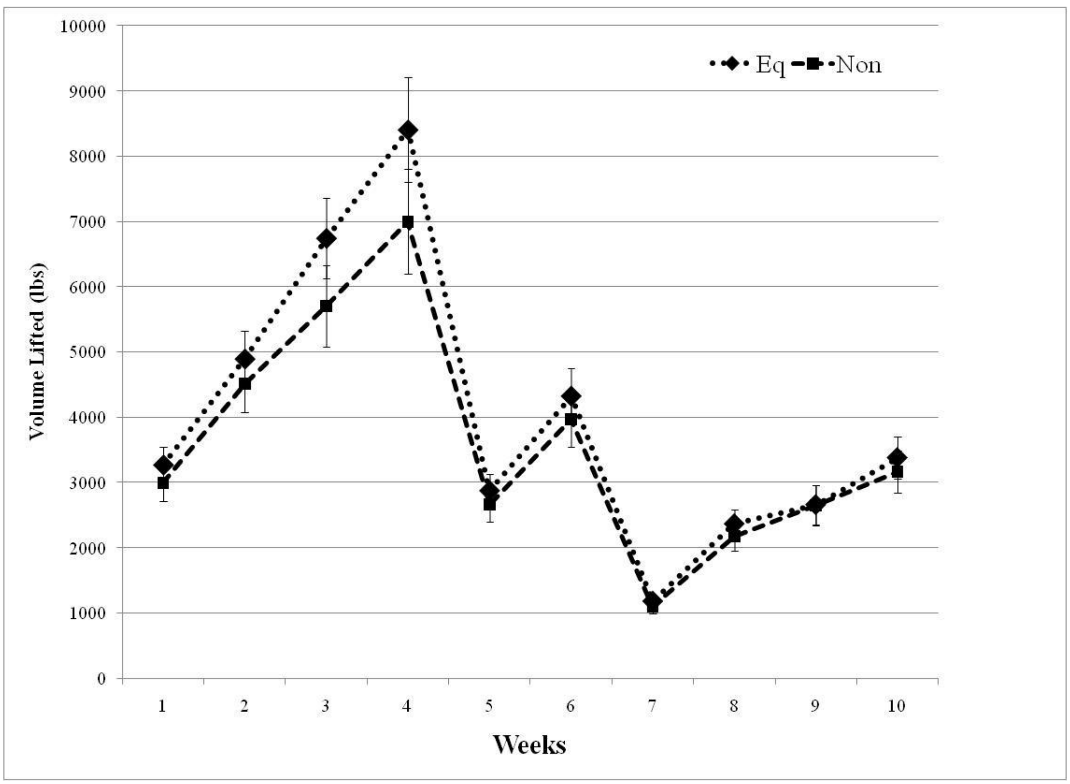

Figure 3.1 Volume of Weight Lifted Across 10 Weeks for Squat Exercise

Powerlifting Performance Measures

Table 3.3 presents the performance measures for the three required lifts: squat, bench press, dead lift, and the totals score before and after the 10 week intervention. There was a

significant increase in squat (↑19.05±30.97lbs, p=0.02), dead lift (↑19.05±21.17lbs, p=0.001) and the Total score (↑44.00±60.44lbs, p=0.005) for both groups combined. Those in the equipped group had meaningful improvements in the squat lift (Eq= 33.85 vs. Non= 5.74, p=0.07), and the Totals score (Eq= 66.59 vs. Non= 23.67, p=0.15). However, the difference did not reach the a-priori alpha level of $p < 0.05$. No trends were noted between the groups for the other performance measures, even when adjusting for pre intervention strength differences, or bodyweight.

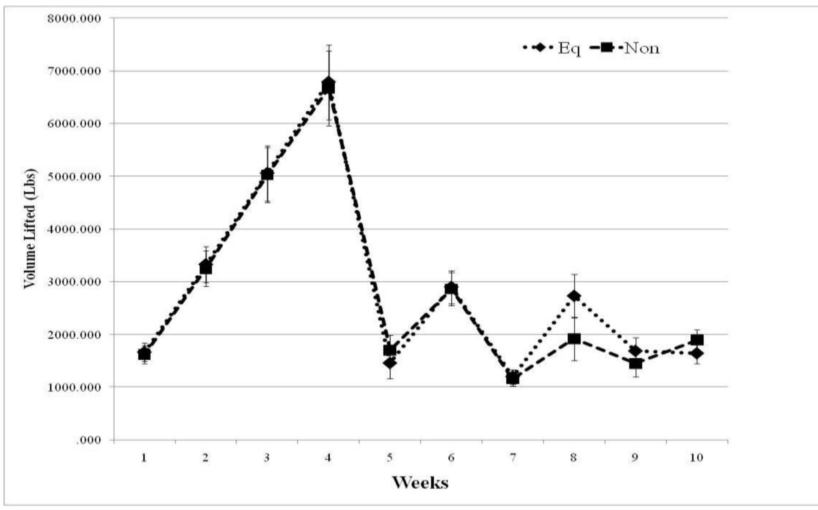

Figure 3.2 Volume of weight lifted across 10 weeks for the deadlift exercise.

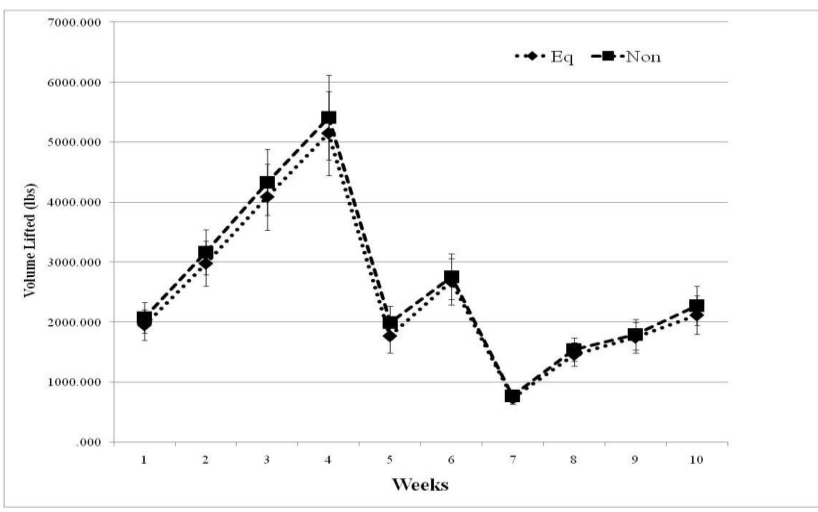

Figure 3.3 Volume of weight lifted across 10 weeks for bench press exercise.

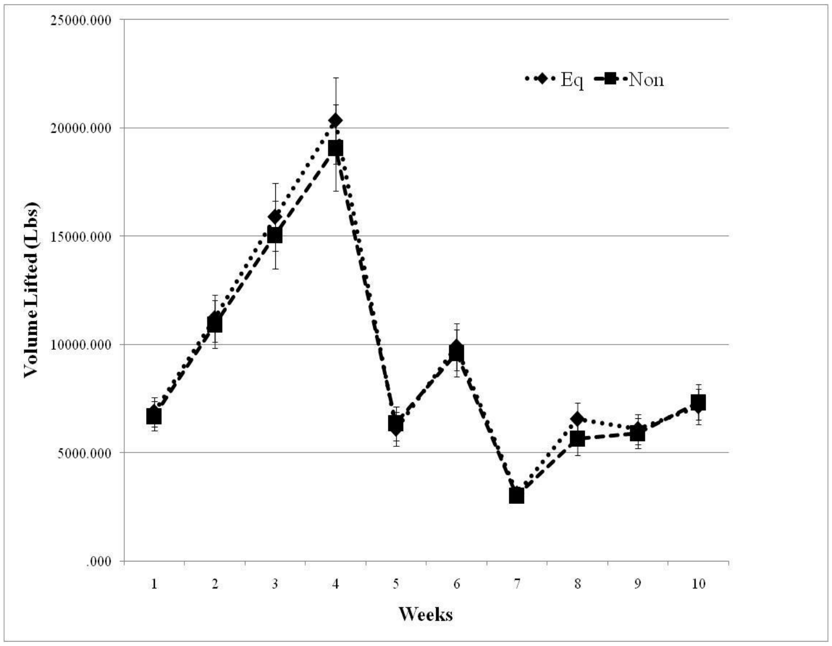

Figure 3.4 Volume of weight lifted across 10 weeks for totals.

Table 3.2-General strength and power measurements

	Group	Pre	Post	Difference
Hand grip right (kg)	**Eq**	45±9	52±16	6.14±16.07
	Non	51±12	56±13	5.49±8.70
Hand grip left (kg)	**Eq**	48±11	57±18	8.97±17.22
	Non	58±15	60±12	1.51±11.51
Vertical (in)	**Eq**	25±4	25±4	0.60±1.43
	Non	28±4	27±4	-0.05±2.03

Wilks Scores

Both groups combined lost an average of 2.67lbs of bodyweight following the intervention (p=0.06). No group differences were observed. Both groups combined showed a

significant increase in the Wilks scores (+13.54 points, p=0.03). However, there were no significant differences between the groups.

Table 3.3. Performance outcomes

	Group	Pre	Post	Difference (lbs)
Squat	**Eq**	510±112	542±113	33.85
	Non	339±116	347±122	5.74
Bench Press	**Eq**	326±83	332±77	7.72
	Non	231±96	236±95	3.25
Dead Lift	**Eq**	504±71	524±71	23.85
	Non	377±140	396±132	14.73
Totals	**Eq**	1336±254	1397±251	66.59
	Non	947±344	978±344	23.67

Table 3.4. Body weight and Wilks scores

	Group	Pre	Post	Difference
BW (lbs)	**Eq**	199±54	196±49	3.44
	Non	171±43	169±45	1.57
Wilks Score (points)	**Eq**	382±71	393±77	11.51
	Non	313±74	329±75	15.91

DISCUSSION

The findings of the study indicate a significant increase in powerlifting performance following the 10 week training cycle. Uniquely, this study also indicates those individuals who trained equipped had a greater improvement in the squat. No differences in performance were noted between the equipped and non-equipped lifters for the bench press, and the deadlift. Finally, both groups showed a significant improvement in their Wilks' scores following the training cycle, indicating the athletes had significant strength gains.

Participant Characteristics

- **Experience Level**

The participants in this study were collegiate powerlifters recruited from the Louisiana State University powerlifting club with experience levels ranging from 1-10 years. However, only one participant had 10 years of lifting experience, and most fell in the 1-4 year mark. There was one male collegiate national champion (former or current) in the equipped group and one female collegiate national champion in the non-equipped group. Besides those two top ranked lifters, the non-equipped group contained 3 collegiate All American lifters (Nationally ranked in the top three of their weight class) compared to 1 All American in the equipped group.

- **Body Composition**

The body composition of the athletes in the present study is fairly typical for this population. On average, the equipped lifters were heavier than the non-equipped lifters by 27.44 lbs., although the non-equipped lifters had less body fat than those in the equipped group (14% and 17.64%, respectively). When taking body composition into account, LBM between the

groups was virtually identical; however the equipped group averaged one weight class higher. This indicates that the average lifter in the non-equipped group carried more muscular bodyweight than the equipped lifters pound for pound.

- **Hemodynamic Variables**

The data in this study revealed several interesting trends regarding the cardiovascular health of competitive powerlifters. The average PWV detected for all lifters was 7.28 m/s (Eq=7.07, and Non=7.48 m/s), which is considered normal for this age group. In fact, several participants measured ~6 m/s, a value indicative of high arterial compliance, and excellent vascular health (SphygmaCor CPV system training). Similar results have been found in other studies, such as one conducted by Fahs et al. that examined aortic stiffness using central and peripheral PWV, as well as augmentation index, muscular strength using the bench press, and VO_2 peak in 79 healthy young men. Their data reflected an inverse relationship between bench press strength and aortic stiffness, with the strongest in the group having the lowest central and peripheral PWV However, the chronic effects of intense strength training on arterial stiffness are poorly understood. Current literature is divided on the issue, and results from numerous studies have either suggested a deleterious effect, no effect at all, or even positive adaptations, although the latter seems to be the minority (Fahs 2005; Heffernan et al. 2010).

Resting heart rates (HR) in the group averaged ~73bpm and resting blood pressures (BP) measured 120/67 mmHg. The resting HR’s in these participants were in the normal range for their age group, although generally higher than endurance athletes of the same experience level (Brooks et al.) Resting systolic and diastolic BP’s were similar between groups (Eq=

[sbp]121±12.37 ; and [dbp] 69± 8.08mmHg, and Non= [sbp] 117± 12.47; and [dbp] 67± 5.59,p>0.05), placing the athletes in the normal range for both BP measurements (ACSM 2006).

Combined, the methods used in this study to examine hemodynamic variables at rest reveal these participants were all in the normal range, suggesting no deleterious effects associated with this sort of training, and no obvious increased risk for future cardiovascular conditions. However, more research is needed to examine the effect that chronic high intensity strength training has on cardiovascular risk factors in strength athletes.

Training Volumes

The prescribed volumes in the training program were derived from the research performed by Soviet sports scientist A.S. Prilepin, who collected data from over 1,000 Olympic, World, National and European weightlifting champions. From the training logs of these champions, he created guidelines (Prilepins table) for developing training volumes by combining sets and reps with training intensities for optimal strength gains (Hristov 2005). Although Prilepins table was developed primarily for Olympic weightlifters, it has been a significant influence for Eastern European coaches for decades to create the most successful powerlifting teams in history. In his book “Power: a scientific approach,” American powerlifting legend Dr. Fred Hatfield refers to Soviet knowledge as a major influence on his training approach, specifically in the areas of periodization and training volumes (Hatfield 1989). Further, the volume progression used in this study is influenced by a program developed by Dr. Hatfield, and follows the guidelines for training volumes based on Prilepins Table, which is illustrated in table 4.1.

Table 4.1. Prilepins Table

Intensity (% of 1RM)	Rep Range	Reps Total	Optimal Reps
<70%	3-6	18-30	24
70-79%	3-6	12-24	18
80-89%	2-4	10-20	15
<89%	1-2	4-10	7

Training volume for each session was calculated by multiplying the total number of sets x reps x top weight used during the workout. Warm-up sets were not included in the daily prescription and the volume for these sets performed before the prescribed workloads were not calculated into the total volume. This was due to each lifter having unique strategies for warming up, with some lifters requiring more or less warm-up sets than others and was thus impractical and potentially dangerous for the lifters to prescribe and record a particular warm-up protocol. Total volumes were recorded and examined for each lift of each participants training session throughout the 10 week intervention. The main purpose in recording and comparing training volume was to examine what difference (if any) existed between groups in the rate of volume increase. This was especially crucial in the first four weeks of foundation training, where the prescribed intensity of 80% could be adjusted according to the athlete’s current strength level (on that day) and would thus give a clear picture of group differences in strength gain without the unpredictable variables that may affect lifting performance during a competition. Comparisons in volume progression are shown in figures 3.1-3.4 of the results section.

- **Base preparation phase (weeks 1-4)**

The purpose of the first four week mesocycle was to build a foundation of strength by utilizing training loads of 80% of the lifters 1RM throughout, and gradually increasing reps per set each week until the apex of volume was reached during the fourth week. According to a meta-analysis conducted by M.R. Rhea et al. that examined studies on the optimal training intensity for maximal strength gain, athletes with 1 or more years of experience exhibit the most gains with workloads of 80% of their 1RM (Zatsiorsky 2006). Many programs developed by successful strength athletes and coaches reflect this idea, such as those whose programs influenced the one in this study, namely Dr. Fred Hatfield (first powerlifter to squat over 1,000lbs in competition) and highly successful Russian Powerlifting Coach Boris Sheiko. However, although the intensity during this training phase was literally calculated at 80% of the lifters 1RM, a subjective RPE scale was utilized by the coaches to determine if the weight was a correct reflection of this intensity. For example, if the lifter reported a rating of 1 (Easy) after the first work set, a supervising coach would adjust the bar weight by approximately 2 to 3% for the subsequent sets. If the lifter reported a 3 (Hard) the weight would be decreased on subsequent sets by 2 to 3%. The rate of volume increase during the foundation training phase is considered an indicator of strength gains and in this study was compared between the equipped and non-equipped groups.

The results of the study indicate that there were no statistical significant group differences regarding the rate of volume increase for any of the lifts or the totals. Perhaps interestingly, it appears the rate of change in volume lifted for the squat was slightly greater in the equipped group (Eq=5062.5lbs, and Non=4396.36lbs). Recognizing there were no significant differences between the groups for the squat, we do appreciate that small changes in athletic

training may translate to small yet important changes in performance. For example, Andre et al. examined the percent difference in performance between first and fourth place in elite track and field athletes, and found variances in performance as low as 1% enough to explain the difference between a gold medal and fourth place (Andre et al. 2010). Typically such a small difference will not result in statistical significance, and the fact that there was no statistical difference makes it hard to suggest any explanation as to why the equipped group had a slightly greater magnitude of change in volume lifted.

- **Meet Preparation phase (Weeks 5-10)**

After the apex of volume was reached during week 4, the focus of the program shifted from gaining a strength base to preparing for competition in the second 4 week mesocycle before the two week tapering period at the end of the intervention. For this reason, the total volume was decreased by lowering the repetitions and sets from 5 sets of 5 reps @ 80% to 4 sets of 2 reps @ 85% during week 5. This decrease in volume allowed for a period of delayed transformation in which the lifter could recover from the volume accumulation during the base preparation phase, while simultaneously adapting to heavier loads (85-95% of 1RM) that would prepare them for competition. As the competition approached, specificity was emphasized by increasing the intensity of the main lifts to 90-95%, while decreasing the total volume (sets and repetitions) to 3 sets of 1-2 reps. Due to the loads being close to the lifters 1RM during this period, special care was taken by the coaches to make sure that the lifters stayed below 100% intensity. Therefore, participants were rarely allowed to increase the bar weight above the prescribed intensity for that session, as was allowed during the base preparation phase. Weeks 9 and 10 was the tapering period in which both volume and intensity were decreased, and it is hypothesized that during this

period of delayed transformation a rebound effect is achieved when the lifter heals from the previous weeks of intense training (Zatsiorsky 2006).

Powerlifting Performance Measures

Both groups combined made significant overall gains in the squat (↑19.05±30.97lbs, p=0.02), the deadlift (↑19.05±21.17lbs, p=0.001) and the total (↑44.00±60.44lbs, p=0.005). There was no change in the bench press for the combined groups. These performance improvements are indeed noteworthy to competitive powerlifters. Specifically, the average improvements of the participants in this study were not very far below the yearly gains of nationally ranked collegiate powerlifters that compete in the same organization. For example, the annual performance improvements of 5 All American (AA) U.S.A.P.L collegiate powerlifters were tracked across their 4 year Collegiate National powerlifting careers and it was observed that the average improvements in the athletes were 32.45lbs in the squat, 18lbs in the Bench Press, and 12.58lbs in the Deadlift per year (USA Powerlifting). The combined group improvement for squat in this study was only 13.4lbs less than the average AA, and the deadlift gain actually surpassed the annual improvements of the AA lifters after only 10 weeks of training. Furthermore, the performance improvements of the equipped lifters matched the annual squat gains of the AA (Eq=33.85, and AA=32.45lbs) and almost doubled their gains in the deadlift (Eq=23.85, and AA=12.58lbs). From these data it is clear that the training program was very effective in producing strength gains in this population.

Although significant differences were not detected between the groups in any of the performance measures, a group difference in the squat (Eq= 33.85lbs., and Non= 5.74lbs, p=0.07) was the largest difference between the groups and approached statistical significance.

Improvements in totals were also greater in the equipped lifters (Eq= 66.59lbs., and Non=23.67lbs., p=0.15), but the group difference was not significant. The 33.85lb increase in the equipped squat is one of the most noteworthy changes in the study, and raises questions as to why the greatest group difference occurred in this lift.

A possible explanation for the greater performance gain in the equipped squat is a superior training adaptation resulting from the extremely high level of blood flow occlusion in the legs while squatting in a suit and knee wraps. Most studies that have examined the effects of blood flow occlusion training have found that higher levels of adaptation have taken place in occluded vs. non occluded working muscles, the mechanisms being unknown at this time (Abe 2010). To examine whether the suit and knee wraps altered blood flow kinetics a case study was performed on a nationally ranked powerlifter. Specifically, blood flow velocity (FVI) was measured in the popliteal artery during four conditions: (1) Supine without suit and wraps, (2) Supine with Suit, and (3) Supine with Suit and knee wraps (see Figure 4.1a-c). At baseline, FVI measured 3.43cm/sec through the popliteal artery. With the addition of a competition squat suit, FVI dropped to 1.84cm/sec, therefore blood flow through the artery was roughly half of baseline. The lifter then applied competition knee wraps in conjunction with the squat suit and FVI then measured 0cm/sec, demonstrating a state of complete blood flow occlusion in that artery.

Additionally, blood flow occlusion that takes place while wearing the squat suit plus knee wraps is specific to the working muscles of the legs that are the prime movers during the Squat, and therefore may be receiving a greater stimulus for adaptation than would a non-occluded leg. In contrast, the Bench Press shirt, although quite restrictive, may not be sufficient to occlude blood flow to prime movers of the pectorals, triceps, and anterior deltoids during the Bench Press lift. In fact, the Bench Press shirt assists the lifter with a reinforced chest plate that acts to resist

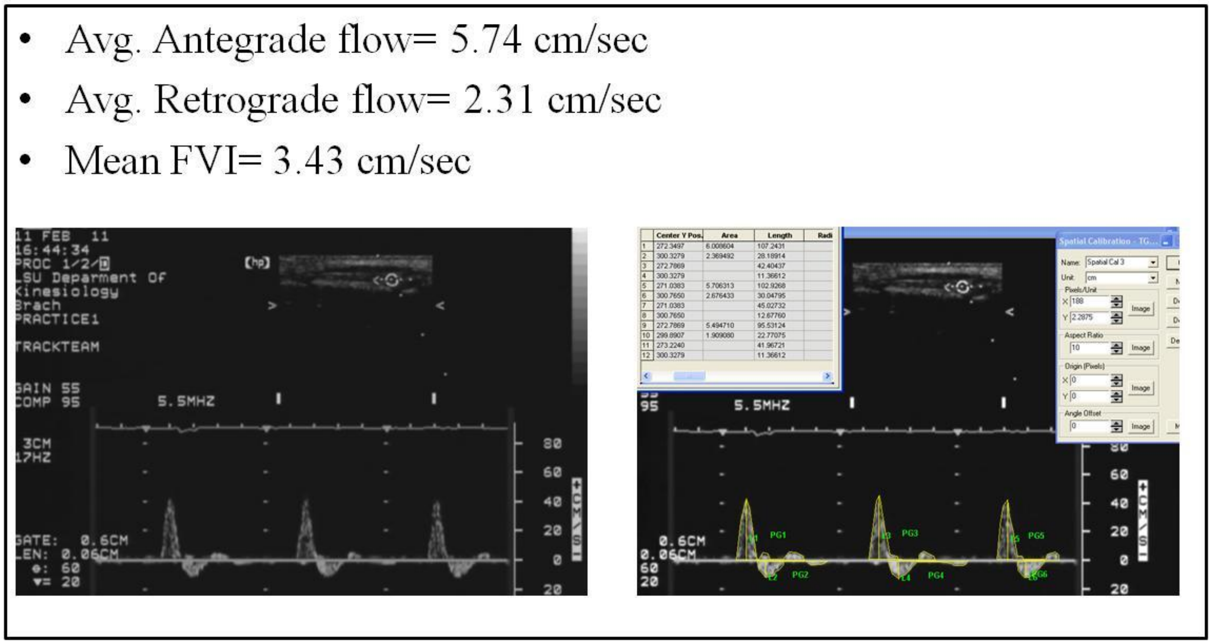

Figure 4.1a. Supine flow velocity signals without suit and wraps.

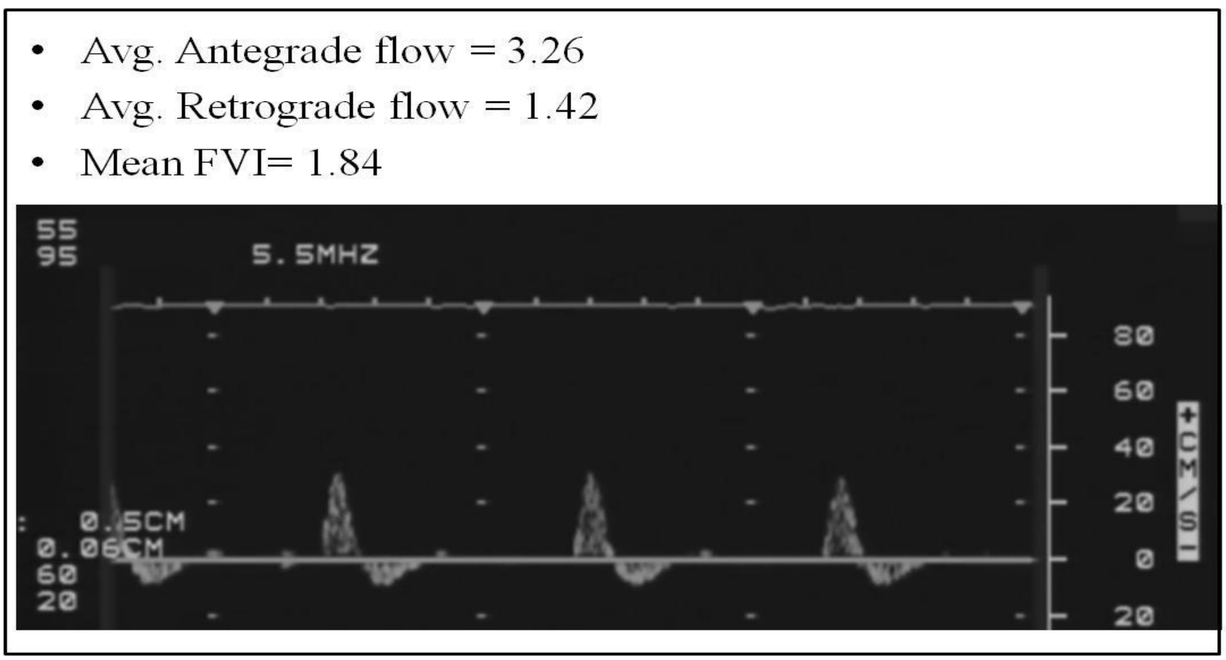

Figure 4.1b. Supine flow velocity signals with suit.

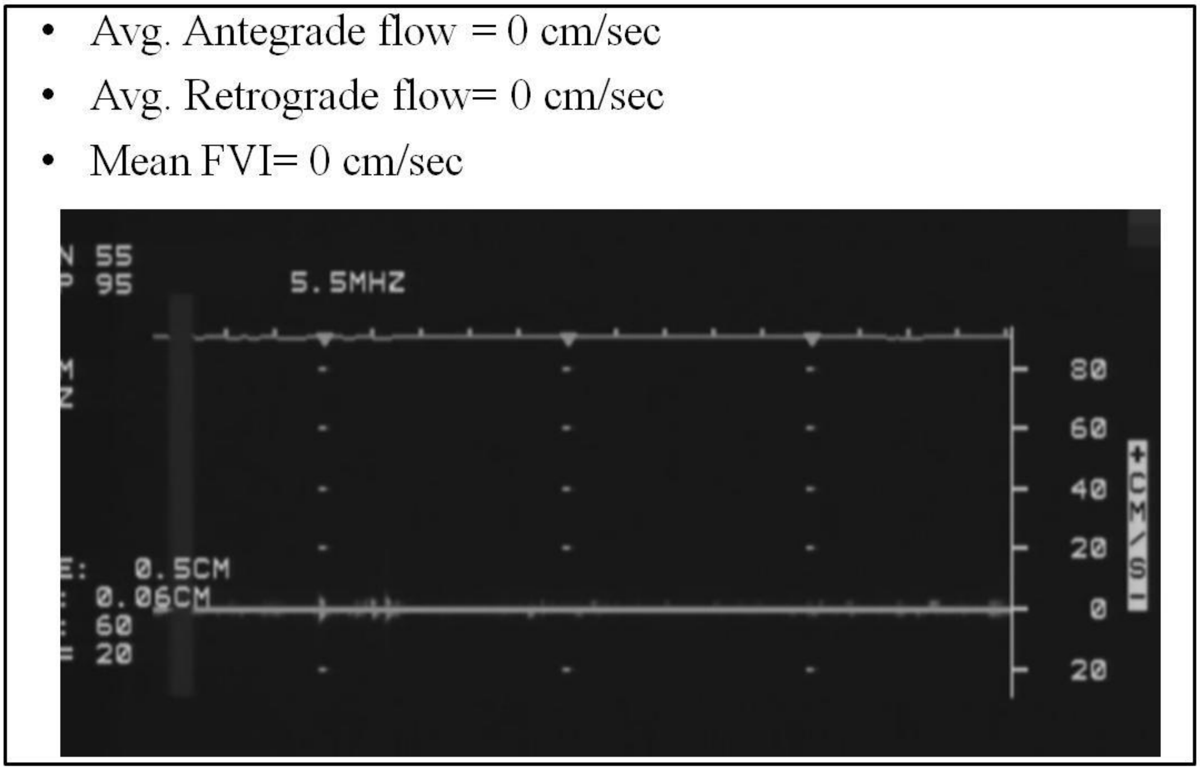

Figure 4.1c. Supine flow velocity signals with suit and knee wraps.

the bar during the eccentric phase of the lift, serving to give the lifter a “rebound” effect during the concentric phase. This action may not result in significant blood flow restriction to the working muscles and therefore cannot be compared to the methods utilized in blood flow restriction studies. Coincidentally, similar gains in performance were seen between equipped and non-equipped lifters in the Bench Press at post testing. Regarding the Deadlift, many lifters experience little to no benefit when using equipment for this lift, therefore the similar performance improvements between the two groups in the Deadlift (Eq=23.85lbs., and Non=14.73lbs.) is not surprising. The Deadlift is an eccentric-less lift that begins from the floor, and cannot utilize the exaggerated stretch reflex provided by the equipment of the Squat and Bench Press. Additionally, success in the Deadlift is largely influenced by the correct body position that allows for the greatest possible leverage. Specifically, the lifter must be able to

achieve a neutral spine with shoulders back and down at the start of the lift, which is made difficult with the use of an extremely tight suit. To illustrate this point, it is important to note that the current world record deadlift of 1015lbs held by Iceland's' Benedikt Magnussun was performed without the aid of a deadlift suit. Furthermore, since most lifters use either a Squat suit for Deadlifting, or a suit almost identical in form to the Squat suit, it can be assumed that no more than 50% blood flow occlusion to the popliteal artery alone takes place during the lift, which, similar to the Bench Press shirt, does not qualify an equipped Deadlift as an occlusion exercise that can be compared to methods used in other blood flow restriction studies.

The degree of technical adjustments that must be made to each lift with use of the equipment coincide with the results in this study, and may help to explain the disparity of gains between the equipped squat vs. the other equipped lifts. Specifically, the biggest group differences were in the Squat lift, where the equipment not only gives the most support over the other two lifts, but also requires the least amount of technical adjustment by the lifter transitioning from unequipped training. Furthermore, the slight technical differences that exist between the two versions of the Squat make the unequipped an excellent auxiliary exercise to improve the equipped Squat, and those that are technically proficient at the unequipped version usually also excel when using equipment. This may be explained by further examination of the specific style of the Squat utilized by powerlifters, and how it relates to the equipment worn during this lift. The powerlifter generally utilizes the low-bar squat in which the barbell rests across the rear deltoids and mid to lower trapezius muscles, as opposed to a high bar squat utilized by Olympic weightlifters in which the bar rests high on the trapezius. The low bar position allows for a near vertical shin position during the eccentric phase, and places the emphasis on the muscles of the erector spinae, gluteal, and hamstrings. These muscles also

receive the most support while lifting in a squat suit, in various ways. First, the tight straps on the suit assist the postural muscles of the lower and mid back and make it easier for the lifter to maintain a neutral spine during the lift. The action of the belt has a similar function, and when worn tight as it was designed to be, creates a high level of intra-abdominal pressure which serves to further stabilize the spine. Secondly, the suit is very tight around the hips and legs, with thick stitching that is sewn to form a "harness" around these areas that tightens as the lifter descends, thereby accentuating the myotatic stretch reflex of the hamstrings and giving the lifter additional rebound from the bottom position of the squat which is the most difficult position in the lift. In order to maximize this effect, the lifter must push the hips the hips back as far as possible during the eccentric phase of the lift, which resists the suit and allows for greater loading of the material that results in more assistance from the bottom position of the lift. In addition, the knee wraps worn during the squat also resist the lifter during the eccentric phase and provide additional rebound during the concentric phase. Since the suit accentuates the natural stretch reflex of the hamstrings in helping the lifter out of the bottom position of the squat, the lifter is taught to squat in the same sequence with or without equipment. Specifically, the first motion when beginning the eccentric phase of the powerlifting style squat is to forcefully push back with the hips, maximizing the recruitment of the posterior chain muscles. The combination of the low bar position with the specific attention to driving the hips back during the lift brings as many muscle groups as possible into the low-bar squat. This allows more weight to be used in this style than other variations such as the high-bar squat and front squat that are commonly used as auxiliary exercises for Olympic weightlifters, and are specific to improving performance in the Snatch and Clean and Jerk. Because of aforementioned functions that the squat equipment utilizes, it not

only provides the most support compared to equipment in Bench Press and Deadlift, but also requires the least amount of practice to master.

In contrast to the Squat suit, the Bench Press shirt is probably the most difficult piece of equipment to master, due to the technique changes that must be made by the lifter to maximize its support. Most Bench Press shirts approved for use in the United States Powerlifting federation are based on a similar design that is meant to reinforce the function of the pectorals and anterior deltoids, giving the lifter rebound off the chest that diminishes through the concentric phase of the lift. Specifically, the short sleeve arm holes are sewn close together, with the chest portion in between consisting of a thick polyester material that is resistant to stretch. Thus the resistance provided by the shirt is twofold; first, the close proximity of the arm holes to one another resist the lifter in reaching and maintain the proper position of pinching the shoulder blades together during the lift, compounding the support provided by the thick frontal material in resisting the weight during the eccentric phase of the lift. As the weight is lowered, the frontal material on the shirt stretches to its maximum capability as the bar reaches the chest, which then gives the lifter a spring effect from the chest that diminishes as the weight is pushed to completion. The degree of help provided by the Bench Press shirt is highly variable and dependant on specific strengths and abilities that are developed by the lifter with years of practice and training with the equipment. For instance, it is often said in the powerlifting community that a lifter must be "strong enough for the shirt," which is true in many aspects. First, the objective of the lifter is to be able to effectively utilize the tightest gear possible in order to receive the most support from its use and thus lift the most weight that he can. However, the equipment (specifically the bench press shirt) only assists in the concentric phase of the lift when it gives the most resistance during the eccentric phase. As previously mentioned, the lifter must be able to overcome the first resistance

offered by the shirt that occurs as he is attempting to retract his scapula, causing the muscles of the trapezius, rear deltoids, rhomboids, and latissimus dorsi to contract. The contraction of these muscles stabilize the torso and allow more force to be directed from the prime movers of the pectorals, anterior deltoids, and triceps to the bar during the concentric phase of the lift.

While bench pressing in the equipment, the stabilizing muscles of the back must be strong enough to retract the scapula against the resistance from the bench press shirt. Furthermore, the lifter must also possess exceptional triceps' strength to full lock out and hold the heavier load at arm's length to complete the lift. Since these muscles are engaged in a way that is very specific to equipped bench pressing, they are best developed through many months or years lifting in the bench press shirt. Therefore there is a greater difference between equipped and unequipped bench pressing than between equipped and unequipped squatting in terms of technical differences in performance, and more time must be spent learning how to use the bench press shirt in order to benefit the lifter. In contrast to the squat suit, which compliments correct unequipped squat technique, the bench press shirt requires a large degree of technical and physiological adaptation, and may be another reason that gains in the equipped bench press were similar to that of the non- equipped group.

Wilks Scores

The participants in this study experienced significant increases in their Wilks scores (+13.54 points, p=0.03), an important measure used in powerlifting competitions to compare the strength of lifters in different weight classes, it is used to award the best lifter of the meet. Since the Wilks score takes bodyweight into account, it is possible for increases in strength to occur even if the absolute weight lifted does not change. Considering that the best lifter of this

competition won by only 2 points, the 13.54 point Wilks improvement seen in this study can be seen as excellent progress.

Relevance

The exercises and training methods of elite strength athletes such as powerlifters and Olympic weightlifters have been integrated into strength and conditioning programs across the world for years, and have proven to be instrumental in creating stronger, faster athletes. However, the equipment worn by powerlifters is an overlooked topic that may have potential as a training aid for athletes, recreational trainers, and clinical populations alike. Further, the squat is generally referred to as the "king of lifts" and is generally employed by every successful strength and conditioning program in the world. The fact that the biggest performance increase in this study involved the equipped squat lift is a topic worthy of further investigation by the strength and conditioning community. Additionally, it is a common point of argument among powerlifters and their coaches as to the amount of training that should be performed in competition equipment in order to see the greatest gains. Since this is the first study to compare equipped and non-equipped training, it may be used as a starting point for further studies to examine this topic in greater detail, and contribute to current training knowledge on the art of strength training. This knowledge can then be applied to any population whose objective is to become stronger or build muscle mass. Additionally, this study adds to the literature on the benefits and possible limitations on blood flow occlusion training, and its application to strength athletes or even clinical populations. Almost all of current research that examines occlusion training utilizes low intensities in their protocols, and none have utilized experienced powerlifters who regularly lift at very high intensities (80-100%) while the muscles in the working limbs are in an occluded state.

Finally, an interesting and unexpected finding that came from this study was that the arterial stiffness of strength athletes engaging in no aerobic training seem to have healthy, compliant arteries. The idea that strength training may increase arterial stiffness is one that is prevalent among the current literature, the topic itself being poorly research that rarely includes pure strength athletes, who give a much clearer picture of chronic adaptations than recreational strength trainers. The healthy hemodynamic responses of the athletes used in this study contradict much of the literature on the subject of strength training and cardiovascular adaptations, and is an area indeed worthy of future examination.

Limitations

Although this study shows some interesting trends regarding equipped vs. non-equipped powerlifting training, it is not without limitations. The heterogeneous makeup of the population with regards to competitive experience (1 to 10 yrs.) and skill level (novice to elite) makes it difficult to contribute group differences in performance solely to the equipment. Coincidently, there was a slight group difference in skill level, with the equipped group containing slightly more novice lifters while the non-equipped group contained more intermediate. Very few elite lifters participated in the study, who may have been less affected by the technical aspects of the equipment, pre competition anxiety, and other variables that affect performance than their novice counterparts.

Another potential limiting factor in this study may have existed in the training design itself. Specifically, both groups performed auxiliary exercises in addition to the main lift of the day that was meant to improve on the weaknesses and muscular imbalances in the lifter. These auxiliary exercises included variations of the main lifts, which were always done sans equipment

in both groups. Taking these auxiliary exercises into consideration, it was detected that approximately 33% of the total volume in the equipped group was performed in the equipment; therefore a large majority of the total volume was actually performed unequipped in both groups. Although a trend has emerged suggesting that the equipped group was handling a greater amount of volume in the squat, this may have been more pronounced if more total volume in the equipped group had been performed in the equipment. Further, it is difficult to say whether the training that was performed in the equipment or the auxiliary exercises that were performed without it was responsible for the strength gains in the equipped group. Future studies should consist of a design that includes more total volume performed in the restrictive equipment, with less unequipped volume in that group.

CONCLUSIONS

The purpose of this study was to examine the effects that powerlifting equipment had on performance measures after a 10 week training intervention. Interestingly, the powerlifters in this study were found to have compliant arteries, suggesting that intense strength training may not have a deleterious effect on arterial stiffness in strength athletes. There was a trend towards greater volume progression in Eq during the first four weeks of training. However, training volume and progression, handgrip and vertical jump were not statistically different between groups. Both groups significantly improved performance for the squat, and deadlift, and had higher totals, and Wilks scores, indicating significant strength gains. The greater magnitude of improvements in the squat and totals for the Eq lifters suggests a potential for a meaningful competitive advantage when training with specialized powerlifting gear.

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APPENDIX: MEMBER AGREEMENT FORM

LSU STUDENT LIFE

University Recreation

SPORT CLUB

Member Agreement Form

PLEASE PRINT IN BLUE OR BLACK INK

Member Name: ______________________________ Sport Club: ______________________

Date of Birth: __________ ID#: ______________ Classification: ______________________ *FR, SO, JR, SR or GRAD*

Local Address: ____

Local Phone: ________________ LSU Email Address: ______________________________

Emergency Contact Name: ____________________ Emergency Phone: __________________

I, ____________________, desire to voluntarily participate in the LSU University Recreation ____________________ Sport Club Program.

I understand that:

- ◊ Coaching instruction is normally handled by non-paid personnel;
- ◊ Often these coaches are sport club members;
- ◊ **It is strongly recommended that before participating in any Sport Club activity that a physical examination by a medical doctor and/or a consultation with a health care provider be done to determine that I am physically and mentally fit and able to participate in strenuous activities;**
- ◊ Club participants have access to the student health center ONLY if they are students;
- ◊ Club participants are not covered under the Department of University Recreation or the University's health insurance policies;
- ◊ Surgeries and other medical complications resulting from sport club participation will not be covered by the Student Health Center and will be the individuals personal financial responsibility; and
- ◊ Club participants will be required to travel to events in privately owned and operated vehicles.

I understand and agree that there is a risk of serious injury to me while utilizing University Recreation facilities, equipment, and programs and recognize every activity has a certain degree of risk, some more than others. By participating, I knowingly and voluntarily assume any and all risk of injuries, regardless of severity, which from time to time may occur as a result of my participation in athletic and other activities through LSU University Recreation.

I hereby certify I have adequate health insurance to cover any injury or damages that I may suffer while participating, or alternatively, agree to bear all costs associated with any such injury or damage myself.

I further certify that I am in good health and have no mental or physical condition or symptoms that could interfere with my safety or the safety of others while participating in any activity using any equipment or facilities of LSU University Recreation. I understand and agree that I alone am responsible to determine whether I am physically and mentally fit to participate, perform, or utilize the activities, programs, equipment or facilities available at Louisiana State University, and that I am not relying on any advice from LSU University Recreation in this regard. To the extent I have any questions or need any information about my physical or mental condition or limitations, I agree to seek professional advice from a qualified physician.

Further, I hereby RELEASE AND HOLD HARMLESS, the State of Louisiana, the Board of Supervisors of Louisiana State University and Agricultural & Mechanical College, and its respective members, officers, employees, student workers, student interns, volunteers, agents, representatives, institutions, and/or departments from any and all liability, claims, damages, costs, expenses, personal injuries, illnesses, death or loss of personal property resulting, in whole or in part, from my participation in, or use of, any facility, equipment, and/or programs of Louisiana State University. In case of an emergency, this consent also authorizes the release of this form and all medical and accident report forms to emergency personal, doctors, hospitals, insurance companies, my employers, other person or entities deemed appropriate by Louisiana State University.

I HAVE READ THIS AGREEMENT AND UNDERSTAND ALL ITS TERMS.

______________________ Signature, Club Member ______________________ Date

______________________ Printed Name, Club Member ______________________ Witness

Revised 7/18/10

VITA

Travis Michael Godawa was born in Baton Rouge, Louisiana, where he attended elementary and high school. He received a Bachelor of Science degree in kinesiology at Louisiana State University in May, 2009. He will receive the Master of Science degree in kinesiology from Louisiana State University in August, 2011.