Impacts of workout supplements in increasing lifting maximums and muscle electrical activity in Allegheny College football players.

By

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I hereby recognize and pledge to fulfill my responsibilities as defined in the Honor Code and to maintain the integrity of both myself and the College community as a whole

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Pledge

Approval by the Senior Thesis Committee

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Abstract

Resistance training is a form of exercise that results in increases in muscle mass and strength. Resistance training has also been shown to play a role in some diseases such as diabetes and heart disease. This type of exercise is critical for athletes who compete in high intensity sports such as football. One way to achieve the results of resistance training faster is by using workout supplements. Supplements allow athletes to undergo more stressful workouts that will result in improved performance on the field. These workout supplements also have the benefit of helping to prevent muscle atrophy, or the loss of muscle. Two of the more popular supplements in the literature are amino acids and creatine. Amino acids are found in many of the popular pre-workout powders on the market, and creatine has been a prevalent supplement for years. Despite knowing the benefits of these supplements some athletes still choose not to complement their workout with these supplements. The goal of this study was to determine if taking a supplement is able to help athletes increase strength and muscle mass after the season ends. At the conclusion of this study the individuals taking a workout supplement saw greater increases in their maximum lifts and muscle electrical activity compared to non-supplement individuals.

Introduction

Resistance training is a form of exercise that results in increases in skeletal muscle mass and strength, like bench press and squat. Resistance training has also been shown to play a role in preventing some diseases like diabetes and heart disease. The importance of resistance training for athletes cannot be understated. In sports such as football, the biggest and strongest are able to perform at a higher level and tend to have fewer injuries than those who do not train as hard. Resistance training is exercise that induces muscle contractions due to resistance and allows

individuals to increase muscle mass. It is critical for non-athletes as well. As one ages, a loss of muscle mass is to be expected. This decline in muscle mass is thought to be one of the causes of diseases like cardiovascular disease and type II diabetes. These diseases may be prevented or slowed by resistance training (Hayes and Cribb, 2008). By remaining active and staying fit, individuals avoid the sedentary lifestyle that leads to risk factors like obesity.

One way to increase the benefits of resistance training comes from changes in the diet or in the form of dietary supplements. To increase these benefits through diet requires increasing one's dietary intake by 500-2000 kilocalories per day (Kreider, 1999). Increasing caloric intake is not as beneficial as supplements due to the fact that it results in weight gain, and the weight is only 30-40% muscle mass, with the remaining weight being fat (Kreider, 1999). Supplements must be used carefully due to risks with legal, ethical, and medical ramifications (Kreider, 1999). Some supplements that fall under this category of high risk are anabolic-androgenic steroids and human growth hormone (Kreider, 1999). Taking an anabolic steroid can cause infertility, increased risk of a ruptured tendon, and psychiatric disorders, among other problems (Pruthi, 2012). These high risk supplements are outlawed by the National Collegiate Athletic Association (NCAA), so any collegiate athlete taking them would be at risk for losing their eligibility.

Other options for dietary supplements are proteins, like whey, or individual amino acids such as beta-alanine and glutamine. Athletes that are taking a supplement of protein may be have little benefit, because even though they may need more protein than an average human they receive enough protein through their diet (Williams, 2005). Excess protein in the body is usually excreted, but if it accumulates it can be harmful due to the excess nitrogen, which is toxic to the brain. Individual amino acids, however, have effects that depend on the chemistry of the specific amino acid. For example, tryptophan is a precursor for serotonin which is a neurotransmitter that

can suppress pain (Williams, 2005). By taking tryptophan one may be able to endure more pain during a high intensity exercise and allow for a longer workout. Another amino acid used as a supplement is glutamine, an important fuel for immune cells (Williams, 2005). By supplementing this amino acid an athlete may be able to prevent the negative impacts of overtraining. Overtraining decreases the number of immune cells like macrophages and lymphocytes (Williams, 2005). This decrease in immune cells can compromise one's immune system, leading to illness that often causes one to stop exercising.

The amino acid beta-alanine is also found in some popular workout supplements like Muscle Pharm's Assault. This supplement is mixed into a drink before a workout. Beta-alanine reacts with histidine in cells to make carnosine (Sale et al. 2009). Carnosine then acts as a pH buffer in muscles to reduce the effect that lactic acid has on muscle fatigue (Sale et al., 2009). When lactic acid builds up in the muscle in the absence of carnosine, muscle activity and ability is reduced (Sale et al, 2009). However, when carnosine is present, lactic acid has a reduced effect on muscle ability, allowing the muscle to work longer without becoming fatigued (Sale et al, 2009). Carnosine is found in fast twitch muscles (Sale et al., 2009), which are involved in short burst or anaerobic activities like sprinting. This would be a beneficial supplement for a football player to take due to the fast pace, high intensity nature of the sport.

A popular supplement used by athletes and bodybuilders is creatine. The popularity of creatine is due to its ability to increase performance in areas of speed, strength, and endurance (Williams, 2006). Creatine is synthesized in the liver and transported to muscles via the blood stream. Once in the muscle it is phosphorylated to phosphocreatine which can donate the phosphate group to ADP to synthesize adenosine triphosphate (ATP), a major energy source in cells (Stoppani, 2014). By taking additional creatine supplement one is able to create more ATP

and have more energy for workouts. The exact mechanism of how creatine affects muscle growth is unclear, but several hypotheses exist.

The first hypothesis of how creatine affects muscle growth involves the regulation of myostatin, a muscle growth inhibitor (Saremi et al., 2010). Mice born with uninhibited production of myostatin had decreased muscle mass compared to those with normal expression of the compound (Lee and McPherron, 2001). In humans, increased levels of myostatin lead to muscle atrophy (Saremi et al., 2010). However, when individuals underwent resistance training, muscle hypertrophy, or the enlargement of the muscle, occurred (Saremi et al., 2010). A similar effect was found when individuals took a creatine supplement, which suggests that creatine may act as a myostatin inhibitor and prevent atrophy (Saremi et al., 2010).

Another hypothesis of how creatine affects the development of muscle growth is that by producing ATP more readily, one's workout can be lengthened, which leads to increased muscle mass (Saremi et al., 2010). As stated above creatine forms phosphocreatine, which produces ATP. By synthesizing more ATP the muscle cells can increase the duration and intensity of the workout (Stoppani, 2014). This increase in both duration and intensity yields a greater gain in muscle mass from resistance training.

A third hypothesis is that creatine may stimulate the production of insulin-like growth factor, or IGF (Deldicque et al., 2004). Insulin-like growth factor is a mediator of growth hormone and plays a role in somatic growth (Clemmons, 2014). Overexpression of IGF in mice leads to muscle hypertrophy (Barton-Davis, et al., 1998). IGF production decreases as humans age and this can lead to muscle atrophy (Barton-Davis et al, 1998). Deldicque suggested that if

creatine is added to one's diet, an individual may be able to increase IGF production and prevent atrophy (Deldicque et al, 2004).

The use of creatine by athletes has been controversial due to perceived side effects of the substance like dehydration, cramping, and increased risk for injury (Greenwood et al., 2003). In one study monitoring the University of Nebraska football team, in which players were taking creatine, these side effects were evaluated and compared to players not taking creatine on the same team (Greenwood et al., 2003). The authors hypothesized that creatine would improve the players' body mass without the side effects of dehydration and cramping (Greenwood et al., 2003). The results of the study showed that players taking creatine were dehydrated less often than non-creatine athletes, and the creatine had little to no effect on their electrolyte balance (Greenwood et al., 2003). The players taking creatine also saw a drop in the number of muscle cramps compared to the players that did not take creatine. The final side effect, increased likelihood of injury, was debunked as well; Greenwood et al. found that players taking creatine had equal or fewer muscle-related injuries than the non-creatine players. The reason for this may be because creatine allows an individual's workout to be more intense and longer, which acclimated their muscles to the stress. At the conclusion of the study the only side effect of taking a creatine supplement was weight gain (Greenwood et al., 2003). This weight gain initially was water weight but transitioned to lean.

Given creatine's popularity and safety compared to other supplements, it is important to look at the results for athletes in regards to fitness. When competing, athletes are at great risk for injury; an injury may result in the athlete missing time in practices and games. An injury like a torn hamstring could also prevent a player from using the affected leg for a long period of time. This lack of use results in muscle atrophy, which leads to decreased performance and

conditioning. The use of creatine in one study, however, was shown to reduce the amount of time the athletes spent rehabilitating injured muscles and allowed them to return to their previous ability level more quickly (Hespel et al., 2001). The study examined 22 subjects and immobilized their legs for two weeks using a cast. The subjects were then divided into two groups; one received a creatine supplement and the other a placebo. Muscle atrophy was the same for both groups, but the group taking the creatine supplement recovered faster than the placebo group.

Supplementation with creatine or an amino acid magnifies the results of resistance training by shortening the time needed to attain a certain level of strength or ability. Creatine increases an individual's fat free mass, lifting ability, and sprint performance compared to a placebo (Kreider et al., 1998). Many studies have examined creatine's effect on exercises like rowing, running, and cycling. During a season an athlete's problems are not limited to on field injuries, they also have the loss of muscle mass accrued during the offseason with peak muscle loss for football players coming at the end of the season. Their muscles often atrophy during the season due to the athletes being unable to lift as regularly during the season compared to the offseason. This is especially true in football players whose bodies may be tired from the strain placed on them during practice and games. For this reason I investigated the use of supplements among football players to see if the supplements are able to help the athletes recover their strength in the offseason. The football team was selected for this study due to three factors; 1) the prior lifting experience shared by the entire group, 2) they also follow the same workout routine, and 3) the coaches and other players ensure that players do the workouts. The Allegheny College Football Team was also a preferable group to test because of the underrepresentation of Division III athletes in the literature.

Methods

For this study I used the Allegheny College Football team as a test population. The football team represents a group of males in the same age range (18-22 years old), all having prior experience with weight lifting and following the same workout schedule. This selection of a relatively homogeneous group removes some of the biases with supplementation like prior exercise experience and consistency of exercise. This study evaluated differences in muscle growth in Division III athletes, a group that has not been studied in the literature. For these reasons the Allegheny College Football team was a good model to evaluate the effect of supplementation on muscle gains made in the offseason.

I sought consent from the football coach and individual players, and players were able to drop out at any time of this study. I distributed a survey to the players to determine who were already taking some form of workout supplement. The survey contained questions regarding supplements (see Appendix for survey). Then the selected players were placed into two groups; supplement (S) and non-supplement (NS). The players continued taking the supplements they already were taking; NCAA rules state that one cannot supply student athletes with supplements. The groups had 5 males in each. Players followed the football team's strength and conditioning program set by the coaches throughout the four month study.

For this study I used the campus weight room to conduct the strength tests, such as the maximum bench and squat. For the arm wrestling I used electrodes, patches, an iWorx leads (collection device), and iWorx software with computer.

On three occasions all participating players performed tests to determine muscle activity and strength. The players also determined their maximum lift for certain lifts at the beginning, middle and end of the study. In December, January, and late February the players tested under the supervision of the football coaches and determined their maximum lift in bench press and squat. The players then participated in an electromyogram activity or arm wrestling contest which determined the activity in their bicep and forearm muscles. The electromyogram activity was completed by attaching four electrodes to the players' right arms and having the electrical impulses recorded by the iWorx software. Over the season my prediction was that players will lose muscle, and will show greater strength in the post season. These results were evaluated using a t test. The lifts were assessed by taking the maximum lift from the third trial and subtracting the maximum lift from the first trial, and then averaged for each group. The EMG results were assessed by taking the active electrical activity and subtracting the resting electrical activity, and the three trials were then compared.

Results

The athletes in this study all completed a survey that asked them about their name, age, willingness to participate in this study, whether or not they were taking a supplement; if they were taking a supplement, the last question was the name of the supplement. From the fifteen respondents, ten were selected and placed into two groups of supplement and non-supplement. At the beginning of the study the supplement group had an average bench press maximum lift of 257.6 lbs while the non-supplement group had an average bench press maximum of 271.2 lbs (Table 3). The average maximum squat lift for the supplement group was 372.8 lbs, and the non-supplement group was 391.2 lbs (Table 4). The conversion of pounds into kilograms is to multiply pounds by 2.2.

At the end of the study the supplement group showed greater increases in their bench press and squat max (Figure 1). The difference in bench press max between the two groups at the end of the study was statistically significant after taking the log of the increases ($p=0.038$), while the squat max was not statistically different ($p=0.18$). Looking at individual members of the supplement group, the participant taking a supplement with creatine as the main ingredient had the largest increase in bench press max, 60 lbs. Another participant taking a supplement with beta-alanine as its active ingredient had the greatest increase in squat, 95 lbs (Figure 2).

In the first trial, the iWorx data showed that the non-supplement group had a larger average increase from resting muscle activity compared to when active. Resting was when a player was not arm wrestling, while active was when the player was arm wrestling. Activity values are reported in absolute integer (Abs Int), which has no units. The supplement group had an average Abs.Int difference (active-resting) of 1.687 for the bicep and 3.488 for the forearm. The non-supplement group had an average Abs.Int difference of 4.06 for the bicep and 4.978 for the forearm for the first trial. In both of the later trials, however the supplement group showed the greater average increase in bicep and forearm activity (Figures 3 and 4). Average Abs. Int in the supplement group was 3.032 for the bicep and 4.704 for the forearm, compared to 2.716 for the bicep and 3.8278 for the forearm the non-supplement.

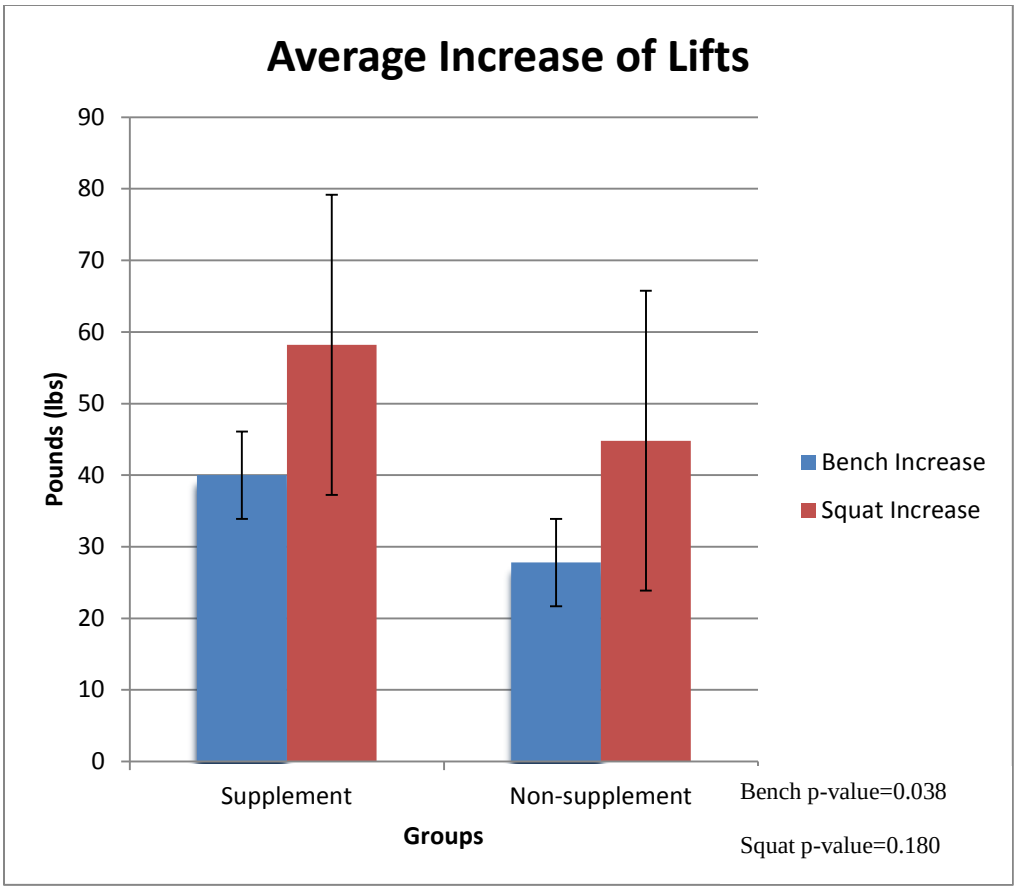


Figure 1: The average increase for bench and squat lifts. The increase was calculated by taking the final – initial max lift. The bench maximum lift was statistically significant.

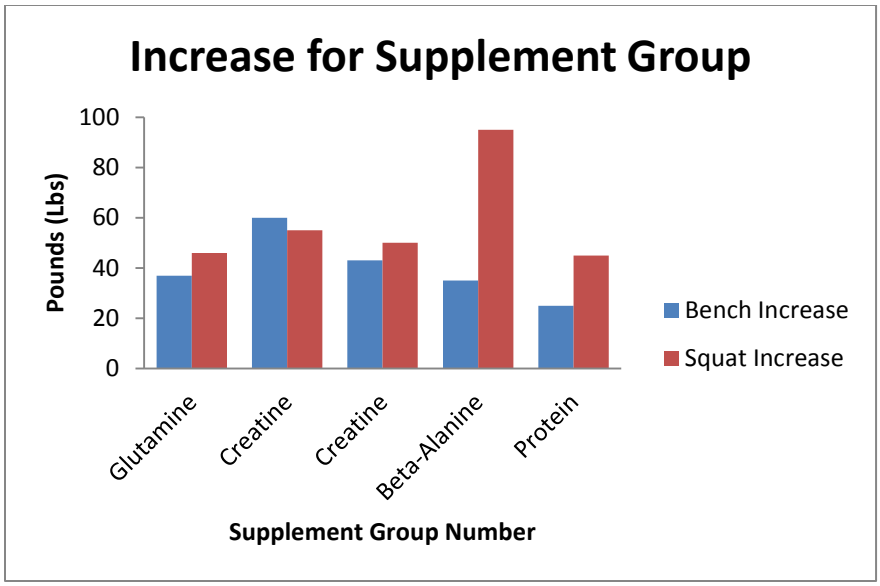


Figure 2: Individual bench press and squat maximum increases for the supplement group.

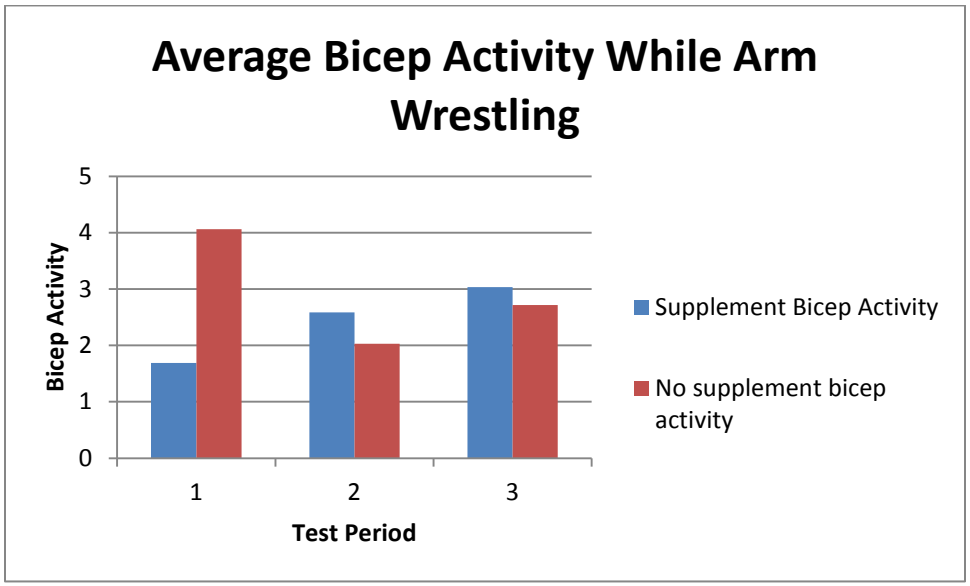


Figure 3: Average bicep activity in supplement and non-supplement groups in three trials.] The data are the absolute integer of the area representing the electrical impulses.

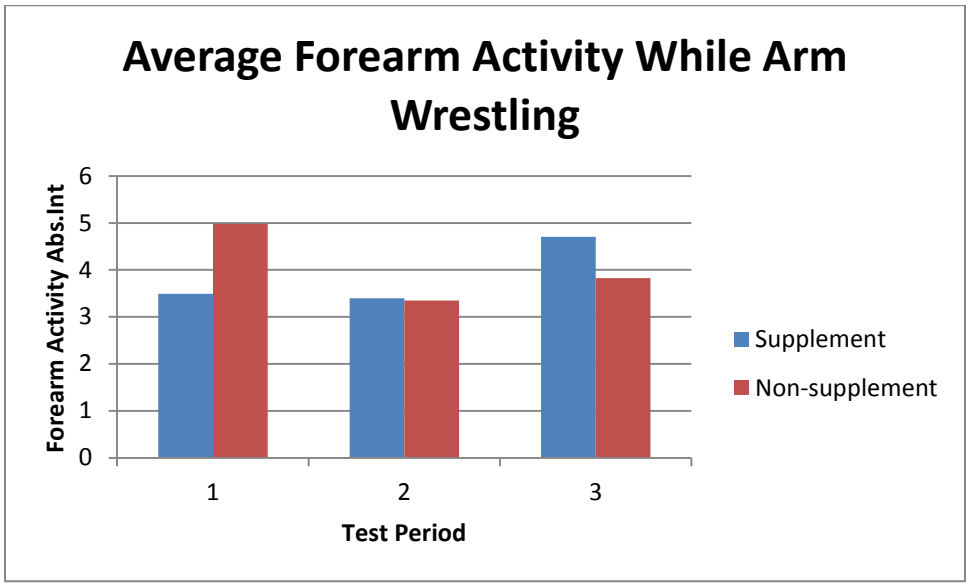


Figure 4: See previous Legend

Table 1: Results of the three bench maximum trials for each participant.

Subject Number	Supplement or Not	Bench (lbs)	Bench 2 (lbs)	Bench 3 (lbs)
1	glutamine	228	260	265
2	creatine and protein	255	300	315
3	creatine and protein	185	200	228
4	beta-alanine and protein	320	320	355
5	protein	300	300	325
6	None	287	310	325
7	None	244	265	270
8	None	287	300	310
9	None	300	300	325
10	None	238	255	265

Table 2: Data from individuals in the non-supplement group: the increase from the first trial to the third, and the difference in the bicep and forearm activity from the first trial to the third trial.

Subject number	Bench lift Increase (lbs)	Squat Increase (lbs)	Bicep Difference (Abs.Int)	Forearm Difference (Abs.Int)
1	38	54	3.059	3.46
2	26	65	2.152	2.412
3	23	31	1.299	2.19
4	25	0	1.944	4.156
5	27	74	5.126	6.921

Table 3: Data for individuals from the supplement group: the active ingredient of the supplement, the increase from the first trial to the third trial, and the difference in the bicep and forearm activity from the first trial to the third trial.

Subject number	Supplement	Bench Increase (lbs)	Squat Increase (lbs)	Bicep Difference (Abs.Int)	Forearm Difference (Abs.Int)
1	glutamine	37	46	1.349	1.959
2	creatine and protein	60	55	8.716	8.046
3	creatine and protein	43	50	1.664	4.299
4	beta-alanine and protein	35	95	1.125	5.200
5	protein	25	45	2.309	4.019

Table 4: Results of the three squat maximum trials for each participant.

Subject Number	Supplement or Not	Squat 1	Squat 2	Squat 3
1	glutamine	334	365	380
2	creatine and protein	345	385	400
3	creatine and protein	265	290	315
4	beta-alanine and protein	430	490	525
5	protein	490	490	535
6	None	416	460	470
7	None	335	375	400
8	None	354	385	385
9	None	440	440	440
10	None	411	430	485

Table 5: EMG values for all participants from the three trials.

Subject Number	Supplement or None	Bicep 1	Forearm 1	Bicep 2	Forearm 2	Bicep 3	Forearm 3
1	Glutamine	2.114	2.037	1.033	1.65	1.349	1.959
2	Creatine and Protein	3.503	4.147	3.524	2.382	8.716	8.046
3	Creatine and Protein	0.688	3.474	1.07	3.9	1.664	4.299
4	Beta-alanine and Protein	1.58	6.84	2.896	3.772	1.125	5.2
5	Protein	0.55	0.944	4.419	5.284	2.309	4.019
6	None	8.57	8.21	0.849	1.502	3.059	3.46
7	None	7.945	6.17	0.791	1.634	2.152	2.412
8	None	0.19	2.083	0.441	1.401	1.299	2.19
9	None	2.25	5.476	2.716	5.739	1.944	4.156
10	None	1.345	2.955	5.361	6.467	5.126	6.921

Discussion

The hypothesis for this study was that athletes who were taking a workout supplement would experience greater increases to their weight lifting ability and would also show greater electrical activity in the bicep and forearm. The players were separated into two groups based on whether they were taking a supplement or not. They were tested in bench press, squat, and arm wrestling on three occasions December 10, January 20, and February 28. While the players taking supplements did show a greater increase in bench and squat maximum, only the bench max was significant compared to the non-supplement group. The iWorx data collection system showed data that were opposite when comparing the first trial with the latter two trials. In the first trial the non-supplement group showed a greater increase in electrical activity from the resting to active position than the supplement group. In the second and third trials the supplement group showed the greater increase from the resting to active position. These results agree with the hypothesis that the supplement group would experience greater increases in their lifting maxes and more electrical activity during the EMG.

Lifting Maxes

All athletes that were in the supplement group saw increases to their bench and squat maxes, ranging from 25 to 95lbs. The individuals taking a supplement with creatine as its main ingredient experienced the greatest increase for their bench max, with an average increase of 51lbs. This finding is consistent with those of Saremi et al., in that individuals taking creatine saw a greater increase compared to individuals in a control group taking other supplements. There are several reasons why creatine appears to be the most effective substance for increasing

bench max. The first reason creatine helped increase their bench max is that creatine is a myostatin regulator; myostatin is a muscle growth inhibitor (Saremi et al., 2010). This inhibition of myostatin allowed the players taking creatine to see greater results compared to those not taking the substance. Another function creatine performs is stimulating the production of IGF which can lead to muscle hypertrophy (Deldicque et al., 2004). The inhibition of myostatin combined with increased IGF production and better workouts led to the greatest increase in bench maximum.

The other three athletes in the supplement group used supplements with main ingredients of glutamine, beta-alanine, or whey protein. Glutamine is an amino acid that can help prevent some of the negative effects of overtraining (Williams, 2005). One of the consequences of overtraining is a weakened immune system, and if one is ill he will not be able to work out and will lose the gains in muscle mass. Glutamine may help prevent problems associated with overtraining such as illness and injuries. Creatine however is able to perform these and other functions that make it superior in regards to increasing bench press max

One supplement used by an athlete had an active ingredient of beta-alanine. Beta-alanine is an amino acid that, combines with histidine, to create carnosine. Carnosine then acts as a pH buffer to prevent the buildup of lactic acid (Sale et al., 2009). This allows the athlete to work out longer and at an increased intensity compared to non-users. This effect of improving workouts still did not seem to have the benefits of creatine with regards to bench max. This is due to creatine having a similar effect in improving workouts by creating more ATP in the cells, and still having all the additional benefits that come with creatine.

The final supplement used by four athletes in my group was whey protein, with one individual taking only whey protein and three individuals taking protein along with creatine or beta-alanine. Protein is critical to building muscle, but most adults receive enough protein through their diet that a supplement of it is not utilized by the body (Williams, 2005). Some of the protein supplement may be used by the athlete who likely has a higher demand for it because of the training but most of the protein is likely excreted as a waste product. This is why the athlete who was taking solely protein saw the smallest increase in his bench and squat max. The idea that a supplement of protein is unnecessary for athletes seems to be strengthened by the fact that the individual who was taking only protein saw a smaller increase, 25lbs, then some individuals in the non-supplement group (23, 25, 26, 27, and 38).

The increases in squat maxes followed a similar pattern to bench in the supplement group; however the athlete who was taking beta-alanine had a much greater increase than those who were taking creatine. One reason for this is that a more intense longer workout may be more beneficial for increasing squat max compared to the benefits brought about by creatine. Another possibility is that the individual's body weight may have affected his lifting increase. The individual who saw the greatest increase in squat was a lineman; linemen are generally heavier than other position players. This reason seems unlikely because the individual with the smallest increase in squat max was also a lineman; however this latter individual was also the one who was taking protein, which may have negated this small increase. The final possibility is that the individual with the greatest increase trained harder than the others and saw greater results. The other athletes in this group had similar results to the bench maxes, those taking creatine had the second and third highest increases, the individual taking glutamine had the fourth highest increase, and the individual taking only protein had the lowest increase.

EMG

For the electromyogram activity data, the non-supplement group had a greater difference in bicep and forearm activity when they arm wrestled compared to when they are rested in the first trial. In the two following trials, however, the supplement group had the larger average increase when comparing an active muscle to a resting one. The original trial shows that the non-supplement group started with stronger bicep and forearm muscles, because of the greater electrical activity (Figure 3, 4). During the next two trials the supplement group showed a greater increase in electrical activity in their muscles which means that between the first and second trials they had overtaken the non-supplement group in terms of strength and activity. This trend agrees with my hypothesis that the supplement group would show greater improvements in muscle activity and strength. However the data was not statistically significant and that the results may have been due to chance with a bicep p-value of .257 and a forearm p value of .241.

The results not being significant could stem from a couple of issues. The first may be that the group size was not large enough to achieve statistical differences. If there had been more participants in both groups, it would have minimized some of the variability in the individuals that appeared after the data was collected. However by adding more athletes to this study the amount of testing would increase significantly, it would be more difficult to ensure that all participants completed the test at a similar time.

Another issue that may have affected the results is that the electrode patches may not have been placed in the exact same location every time. Since this study was looking at the

effects of supplements over a few months, the tests needed to be spread out over 4-5 weeks intervals. The instructions for the iWorx lab provided a diagram for the general locations the patches, but due to human error they may have been located in slightly different locations from trial to trial. This could have resulted in a different number of electrical impulses being detected based on where the electrode was placed. For example if during the first trial the bicep electrode was placed in the center of the bicep but in the third trial the electrode was placed more towards the edge of the bicep the activity in trial one would appear greater than in trial three.

The final issue that could have impacted the data is sampling error. If the groups were not perfectly matched in terms of the number of linemen or skilled position players in each group it could have skewed the results in an unintended direction. In the non-supplement group there were four linemen, while in the supplement group there were only two. This may have had some impact on the results if your body size played a role on the muscle growth of the biceps and forearms. This seems unlikely because this distribution of athletes did not influence the lift results.

Conclusion

My hypothesis for this study was that the athletes who took a workout supplement would experience a greater increase in their lift maximums, and that they would experience greater electrical activity in their biceps and forearms. The data showed that the athletes who took a workout supplement did see greater improvements in all these areas, however not all of the data reached statistical significance. The athletes who took creatine for this study showed the greatest improvement in their bench maximum, and the second greatest in squat maximums. This was the overall most beneficial supplement. The amino acids glutamine and beta-alanine were also useful

with the player taking beta-alanine showing the greatest increase in squat maximum. Protein appears to be the least effective supplement tested, due to the increases made by the player taking only protein being smaller than individuals in the non-supplement group. If I were to repeat this study again I would increase group sizes and select a wider variety of lifting tests to examine other muscles.

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Appendix A: Consent Form

Informed Consent Agreement

Please read this consent agreement carefully before you decide to participate in the study.

Purpose of the research study: This project will look at the prevention of muscle loss in football players during the season, and muscle gain in the offseason. The loss of strength can lead to injury and decreased performance. Players will be divided into two groups, those that take a supplement and those that do not take a supplement. The players will complete the workouts set by the Allegheny College Football Team. I will record muscle activity and strength during the season, 1-2 weeks after the season, and during the offseason. The rationale of this project is to determine whether supplements help to retain strength during the season, and help you gain muscle in the offseason.
What you will do in the study: The players will be placed into one of two groups, either taking a supplement or not taking any supplements. The players will continue taking tor not taking he supplement they choose, because per NCAA rules I am not allowed to give supplements to players. The groups will have between 8-12 players each. The players will follow the football team's strength and conditioning program as set by the coaches. On three occasions, during the season, at the end of the season, and in the post-season, each player will participate in tests of muscle activity and strength, including grip strength. The players will also determine their maximum weightlift at the beginning and end of the experiment. Finally the players will perform an electromyogram or arm wrestling contest which will determine muscle activity. Typically those with greater muscle mass will show greater muscle activity. The arm wrestling test will take about 15 minutes for each player.

Time required: The study will require about 2 hours of your time in total on 3 separate occasions.

Risks: Injury occurring from weightlifting program

Benefits: There are no direct benefits to you for participating in this research. The study may help us understand if supplements are beneficial in maintaining or gaining strength.

Confidentiality: You will only be identified in this study by your academic year (Freshman, Sophomore, etc.) and whether or not you are taking a supplement.

Voluntary participation: Your participation in the study is completely voluntary.

Right to withdraw from the study: You have the right to withdraw from the study at any time without penalty.

How to withdraw from the study: Contact me either in person or by phone (724-288-8091) and let me know you would no longer like to be part of the study. (If possible earlier in the process.)

If you want to withdraw from the study, there is no penalty for withdrawing. .

Payment: You will receive no payment for participating in the study. **If you have questions about the study, contact:**
Tyler Clark

Allegheny College
Telephone: (724)288-8091
Email address: clarkt@allegheny.edu

Dr. Christy Donmoyer
Biology Department, Allegheny College
Telephone: (814)332-3021

Email address: cdonmoyer@allegheny.edu

Agreement:
I agree to participate in the research study described above.

Signature: _____ Date: _____

You will receive a copy of this form for your records.

Appendix B: Survey

Comp Survey

1. What is your class year?

2. Do you take a workout supplement? Examples) creatine, protein amino acids, or any othe pre/post workout.

3. If yes what is the name of the supplement.

4. Would you be willing to participate in a senior comp study? The study will have you follow the football team's weightlifting program, and look at the gains for those who take a supplement compared to those who do not.

5. What is your email address?

Appendix C: Example of workout

1/21			1/22		
Push Press (DE)			**Snatch (ME)**		
	x5			x6	
	x5			x6	
	x5			x5	
Neutral Grip DB Bench			**DB Lunges (ME) - Each Leg**		
	x8			x 10	
	x8			x 10	
	x8		Lower Weight	x 10	
DB Bent Over Rows/ Bench Push Ups			**DB One Legged Squats**		
	x10			x 8	
	x8			x 8	
	x8			x 8	
DB Standing Military Press			**DB Lateral Lunges/Bench Toe Taps**		
	x 12		**SS**	x 10	
	x 12			x 10	
KB Swings (DE)			**Big Band Side Steps**		
	x 3			x 10	
	x 3			x 10	
	x 3			x 10	
MB Wall Throws / Skinny Bands Curls (DE) **Hold Handles step on Middle**			**BB Hip Mobility Drills x 5 es**		
			Lateral Over/Under, Fwd, Bwd		
	x 6 es / 20				
	x 6es/ 20				

SS - Super Set

BB - Barbell

DB - Dumbell

(ME) - Max Effort: Heavy

(DE)-Dynamic Effort: Speed -Use lighter Weight

Appendix D: Example of EMG reading

