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The Effects of Whole Body Vibration on Strength Gains in the Bench Press, the Back Squat, and the Power Clean in Division I Football Players

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ABSTRACT

The Effect of Whole Body Vibration on Strength Gains in the Bench Press, the Back Squat, and the Power Clean in Division I Football Players

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The purpose of this study was to determine if whole body vibration effects strength gains in the bench press, the back squat, and the power clean in division 1 football players. Thirty-one NCAA Division 1 male football players volunteered for this study and were randomly assigned to a control group (C=16) or one of two vibration groups (V1=7, V2=8). Subjects followed the training program for eight weeks. A pre-test, mid-test, and post-test one repetition max was measured at 0, 4, and 8 weeks for the bench press, the back squat, and the power clean. A 3x3 factorial ANOVA revealed varied results between the three lifts performed. In the bench press, there were no significant differences in strength gains between the three training groups (F=.616, p=.547). In addition, there was no significant interaction (F=1.05, p=3.74). There were significant differences between trials in the bench press in strength gains (F=7.570, p=.006). In the back squat, there were no significant differences in strength gains between the three training groups (F=.847, p=.440). In addition, there were no significant differences in interaction (F=1.734, p=1.83). There were significant differences between trials in the back squat in strength gains (F=17.111, p<.001). In the power clean, there were no significant differences in strength gains between the three training groups (F=.666, p=.522). In addition, there were no significant differences in interaction (F=.113, p=.912). There were significant differences between trials in the power clean in strength gains (F2=26.249, p<.001). While all groups registered significant strength gains over trials, there were no significant differences in strength gains between any of the three treatment groups or any of the three dependant variables. It was concluded that whole body vibration does not enhance strength gains in division I football players.

Keywords: whole body vibration, football, strength gains

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Introduction

Athletes around the world are continually trying to find an edge over their competition. New exercise interventions are being studied and tested continually to help improve an athlete's performance. One way to increase an athlete's performance is to increase their explosive strength, or the ability to develop force within a short time (17). For this reason it is important to find interventions that will compliment strength training lifts, such as the bench press, the back squat, and the power clean. These three lifts are considered the most commonly used in strength training for many sports (11).

Lately, whole body vibration has been looked at to compliment or substitute common exercise routines. Several studies have been published regarding whole body vibration and the effect it has on strength and power output with athletes (1, 3, 4, 5, 6, 9, 17).

Vibration platforms are most commonly utilized for subjects to stand on and obtain a mechanical stimulation from their feet (17). When the stimulus of the vibration reaches the skeletal muscle it is thought that muscles change in length which in turn stimulates the muscle spindles. It is believed that this stimulation of the muscle spindles creates more rapid neuron activation and thus helps increase a higher threshold of fast twitch motor units (6).

The majority of the studies that have been conducted on the relationship of whole body vibration to strength gains have examined the back squat. Researchers have found a significant effect on strength gains in the back squat while implementing whole body vibration in selected popultaions (1, 10, 13, 15). Ballerinas were also studied to compare the increase of the back squat while implementing whole body vibration. The study found a significant increase

compared to the non-vibration group. The whole body vibration group increased their back squat by 32% in a five-week period (1).

Whole body vibration has been studied thoroughly in relationship to untrained individuals and the older population. In these two populations, there have been significant findings on the positive effect whole body vibration has had on strength gains (2, 7, 12, 14, 16, 17). The one area where research is lacking is in the area of the effects whole body vibration is on trained athletes, specifically male trained athletes (3, 17). The few studies that have examined athletes and the implementation of whole body vibration in their training regiments have mostly used female athletes for their studies (1, 5, 9, 15, 17). Although, Lamont et al. found a significant increase in jump performance in male athletes while implementing whole body vibration in squat training in a six week training session (10).

No studies have been performed on the effects that whole body vibration has on the bench press or the power clean. Few studies exist that have looked at strength gains in upper-body lifts while implementing whole body vibration (4, 8).

The purpose of this study was to determine if whole body vibration had an effect on strength gains in the bench press, the back squat, and the power clean of Division I football players during an eight-week resistance training program.

Methods

Experimental Design

A repeated measures factoral ANOVA (3 groups x 3 trials x 3 dependant variables) randomized controlled trial experimental design was used to compare the effects of whole body vibration on strength gains in the bench press, the back squat, and the power clean. A pretest was taken prior to the first week of training, followed by a midtest taken after week four of the training, concluded by a posttest that was performed after week eight of the training.

Subjects

Thirty-Nine NCAA Division 1 male football players volunteered to participate in the study. At the completion of the study thirty-one remained in the study and eight subjects dropped out. A variety of position groups were represented on the football team including: defensive backs, wide receivers, tight ends, linebackers, running backs and offensive and defensive lineman. All subjects read and signed the informed consent approved by the Institutional Review Board of Brigham Young University prior to participation. Thus, subjects were assumed to be typical of other Division I football players.

Data Collection

Random assignments to the three groups used the matched pairs ABC assignment procedure according to the one repetition maximum of the three lifts that were performed in the pretest. Athletes were ordered according to their total weight lifted from highest to lowest. Starting at the person who had the most weight lifted we applied ABC to the three highest lifters.

For the next three we assigned BCA. For the next three we assigned CAB. We continued this method until all subjects had been assigned to a group.

The control group (C) completed the workout designed by the head strength and conditioning coach without any implementation of whole body vibration.

Vibration group 1 (V1) performed the following: prior to each set of the bench press, the back squat, and the power clean the subjects got on the vibration plate. The vibration plate was set at 40 Hz for each lifting set performed. Before sets of the bench press were performed, subjects placed their hands on the vibration platform and performed an isometric push-up at midpoint (elbows half way bent). The subjects stayed on the platform for 10 seconds, rested for 10 seconds, got back on for 10 more seconds, and then performed their given set of the bench press.

Before sets of the back squat were performed, subjects stood on the vibration platform and performed an isometric squat at parallel position (thighs are parallel to the floor). The subjects stayed on the platform for 10 seconds, rested for 10 seconds, got back on for 10 more seconds, and then performed their given set of the back squat.

Before sets of the power clean were performed, subjects stood on the vibration platform and performed an isometric squat at mid-position (knees are slightly bent as if one was performing a hang clean.) The subjects stayed on the platform for 10 seconds, rested for 10 seconds, get back on for 10 more seconds, and then performed their given set of the power or hang clean.

Vibration group 2 (V2) performed the following: prior to each set of the bench press, the back squat, and the power or hang clean the subjects got on the vibration plate. The vibration plate was set at 40 Hz. Before sets of the bench press were performed, subjects placed their

hands on the vibration platform and performed an isometric push-up at midpoint (elbows half way bent). The subjects stayed on the platform for 20 seconds and then performed their given set of the bench press.

Before sets of the back squat were performed, subjects stood on the vibration platform and performed an isometric squat at parallel position (thighs are parallel to the floor). The subjects stood on the platform for 20 seconds and then performed their given set of the back squat.

Before sets of the power or hang clean are performed, subjects stood on the vibration platform and performed an isometric squat at mid-position (knees are slightly bent as if one was performing a hang clean). The subjects stood on the platform for 20 seconds and then performed their given set of the power or hang clean.

Measurements

Prior to participating in the strength training program a pretest was performed to determine each athletes one-repetition maximum in the bench press, back squat, and power clean. A midtest assessment took place after week four of the training session and one-repetition maximum was measured for the bench press, the back squat, and the power clean. A posttest assessment took place after week eight of the training session and a one-repetition maximum was measured for the bench press, the back squat, and the power clean. Participants performed an initial warm-up for each lift prior to performing their one-repetition maximum. Participants followed the sets and repetitions for each set that were given to them by the Brigham young University Head Strength Coach. The sets and repetitions were determined based on how subjects had tested in the past. Participants then increased the resistance weight for each lift until

they could not lift the given weight. Each subject was given two to five minutes of rest between each testing set. This was repeated for the bench press, the back squat, and the power clean for each of the pretest, midtest, and posttest.

Statistical Analysis

A repeated measures factorial ANOVA (3 groups x 3 trials x 3 dependant variables) was computed for the bench press, back squat, and power clean to determine if there were significant differences between the three training groups, the three trials of each group, and interaction. When significant p-values were found between groups and/or within trials, a Tukey's post hoc test was used to identify specific mean differences (Vincent, 2009). The assumption of sphericity was met. Bonferroni's Adjustment was applied to the alpha levels to protect against Type I Error (.05/3 = .02). A power analysis was completed to determine how large each group must be to generalize to a larger population.

Results

In the analyses that were performed, there were varied results between the three lifts. In the bench press, there were no significant differences in strength gains between the three training groups (F=.616, p=.547; Figure 1, Table 1). In addition, there was no significant interaction (F=1.05, p=3.74; Figure 1, Table 1). Further analysis using Tukey's post hoc test revealed there were significant differences between trials in the bench press in strength gains (F=7.570, p=.006; Figure 1, Table 1). (V1) improved from the pre-test to the post-test ($p < .05$) and also from the mid-test to the post-test ($p<.05$). (V2) improved from the pre-test to the mid-test ($p < .05$). (C) improved from the pre-test to the post-test ($p < .05$).

In the back squat, there were no significant differences in strength gains between the three training groups (F=.847, p=.440; Figure 2, Table 2). In addition, there was no significant interaction (F=1.734, p=1.83; Figure 2, Table 2). Further analysis using Tukey's post hoc test revealed there were significant differences between trials in the back squat in strength gains (F=17.111, p=.000; Figure 2, Table 2). (V1) improved from the pre-test to the post-test ($p<.05$) and also from the pre-test to the mid-test ($p< .05$). (V2) improved from the pre-test to the post-test and also from mid-test to post-test ($p< .05$). (C) improved from the pre-test to the post-test ($p< .05$).

In the power clean, there were no significant differences in strength gains between the three training groups (F=.666, p=.522; Figure 3, Table 3). In addition, there was no significant interaction (F=.113, p=.912; Figure 3, Table 3). Further analysis using Tukey's post hoc test revealed there were significant differences between trials in the power clean in strength gains (F2=26.249, p=.000; Figure 3, Table 3). (V1) improved from the pre-test to the post-test ($p< .05$) and also from the mid-test to the post-test ($p <.05$). (V2) improved from the pre-test to the post-test ($p < .05$) and also from the mid-test to the post-test ($p< .05$). (C) improved from the pre-test to the post-test and also from the mid-test to the post-test ($p< .05$).

Discussion and Implications

The results of this study indicate that there were no significant differences in strength gains between the three different training groups. After all three groups participated in the same strength training program for eight weeks, the study found that tradition strength training with whole body vibration had a significant effect on the trials, but it was no greater than the effect on strength gains observed in the control group. Between the two different vibration groups, there

was not one technique that was more effective in the trial periods. Thus we concluded that between V1 (10 sec on, 10 sec off, 10 sec on) and V2 (20 sec on consecutively) neither technique was more effective than the other. All three groups experienced significant improvements in strength gains over the eight week period in all three lifts.

To our knowledge, this was the first study performed that used Division 1 football players in a whole body vibration study that examined strength gains in the bench press, the back squat and the power clean. There have been other studies that have examined strength gains in the back squat while implementing whole body vibration in trained athletes (1, 10, 15). Most studies that have involved whole body vibration have used an elderly population or untrained athletes (2, 7, 12, 14, 16, 17). The findings of this study do not coincide with other studies that found that whole body vibration can have a positive effect on strength gains in the back squat in athletes (1, 10, 15).

In regards to the strength gains in the back squat in this study, both vibration groups experienced significant increases in strength between trials but not between groups or interaction (V1= +6.5%, V2= +11.4%; Table 2, Figure 2) The C group also had significant increases in strength between trials, concluding that there is no difference between V1, V2, and C (C= +5.2%; Table 2, Figure 2). Although all three groups improved significantly from pre-test to post-test(V1=, there were no differences between groups in the back squat.

In regards to strength gains in the bench press, V1 was the only vibration group that experienced an increase in strength gains between trials, but there was no significant increases between groups or interaction (V1= +5.1%; Table 1, Figure 1). V2 did not experience an significant increase in strength gains between trials ,but the C group did experienced significant

increases in strength gains (V2= +1%, C= +4%; Table 1, Figure 1) thus concluding that there is no difference from the C group to V1.

The power clean results were the most similar between the three groups of all of the three lifts. In regards to strength gains in the power clean, V1 and V2 experienced an increase in strength gains between trials, but there was no significant increases between groups or interaction (V1= +8.1%, V2= +8.2%; Table 3, Figure 3). The C group also experienced significant increases in strength gains (C= +9.4%; Table 3, Figure 3), thus concluding that there is no difference from the C group to V1 and V2 in regards of what technique to use to gain strength.

Strength gains in V1 and V2 differed slightly in when the strength gains occurred. In the study conducted by Lamont et al. (10), his study indicated that the implementation of whole body vibration with the back squat produced the biggest increase in strength gains between week three and seven. In our study, we found that V1 and C groups saw their biggest increase of strength between the mid and post tests (between four and eight weeks). Both groups in all three lifts experienced their largest increase in strength gains in their one repetition max between the mid-test and the post-test (which would be between weeks four and eight). This is true for all lifts except the bench press and V2. V2 experienced the largest increase in bench press strength gains between weeks one and four and actually experienced a decrease in strength between weeks four and eight. These results generally agree with the study conducted by Lamont et al. (10).

On the basis of an athlete's response to whole body vibration, this study illustrates arguments for both sides. This study is in agreement with the study conducted by Cochrane and Stannard (5) that studied a women's field hockey team that experienced an increase in the vertical jump after

implementing whole body vibration. In this study, the findings of improvements in strength gains in all three lifts, primarily the back squat and the power clean, illustrates that whole body vibration does not inhibit strength gains compared to a control group.

This study can also take the side that Delecluse et al.(6) and Wilcock et al. (18) took after conducting their study. Delecluse et al. (6) examined male and female sprint-trained athletes. In their study they found no significant gains in maximal leg strength, stating that motor unit excitability and fast twitch muscle fiber recruitment was already developed before whole body vibration was added. Wilcock et al.(18) implemented whole body vibration with a men's rugby team and maximal squat strength and found no significant strength gains over a six week period. In this study, the results of strength gains in all three lifts could conclude the same findings as Delecluse et al.(6) and Wilcock et al. (18). Most of these athletes could have been near their peak maximal strength, thus not experiencing significant strength gains over the eight week period.

The vibration frequency that was used in this study was 40Hz. This frequency was chosen due to previous research (8). Hazell et al. (8) found that the greatest EMG responses were measured in the range of 35-45 Hz. The vibration platform that was used in the study had settings of 30Hz, 40Hz and 50Hz. For this reason, the 40 Hz setting was designated for both groups. The results of this study suggest that the frequency of 40 Hz does not inhibit whole body vibrations effect on strength gains in the three lifts that were performed. Hazell et al. (8) also stated that muscle activity was greater in the lower body rather than the upper body while standing on the vibration platform. For this reason, in our study prior to performing the bench press the subjects were asked to perform an isometric push up where their hands were in direct contact with the vibration platform to help stimulate the muscle activity in the upper body.

As for the time spent on the vibration platform prior to performing the actual set of the lift, our study found that there was no one method that was more effective than the other including the control group. V1 and V2 had almost the same percent improvement in strength gains in the power clean from the pre-test to the post test and from the mid-test to the post-test and from the pre-test to the post test. The lifts where the two methods differed were in the back squat and the bench press. V1 tended to give more percent improvement in strength gains over the eight week period to the bench press than V2. V2 actually lost strength between week four and eight, which could be due to a fatigue factor to the upper body after holding an isometric push up position for 20 consecutive seconds. This is compared to V1 who performed a 10 second isometric push with a 10 second rest and then performed another 10 second bout of an isometric push up. With regards to the back squat, V1 and V2 both had significant strength gains over the eight week period. The only difference between the two groups with the back squat was when the largest strength gains took place. V1 gained the most strength between week one and four. V2 gained the most strength between week four and eight.

To summarize, whole body vibration does not appear to have a significant effect on strength gains in the bench press, the back squat, and the power clean over the eight week period when compared to the control group in division I football players. This lack of group differences may have been caused because the subjects in the study (division I football players) may have been near their maximal strength values prior to the study and the standard deviations of the groups were extremely high due to the intermixing of position groups (ie., offensive lineman with defense backs). More studies are needed with male athletes to determine if whole body vibration has a significant effect on strength gains in trained individuals. Further studies will need to be conducted to examine the validity of upper and lower body activation with whole

body vibration. Optimum time spent on the vibration platform prior to performing a set of a preferred lift must be examined in further detail to determine which is most effective.

A limitation of this current study was that grouping of "skill" players (defensive backs, wide receivers), "combo" players (running backs, linebackers, tight ends), and "big" players (offensive and defensive line) needed to be kept separately from each other to prevent the large standard deviations between each group (V1, V2, C). Due to this limitation, a further study needs to be conducted that will not intermix the "skill", "combo", and "big" players together, but keep them separate and follow the same procedures that were conducted in this study. A second limitation of this study was the frequency that was used for each subject, 40 Hz. Due to the physiological differences between each subject, this frequency of 40 Hz could have had a different effect on each subject in a positive or negative way. Further studies need to be conducted to examine how a different frequency for each subject could help a subject reach their optimal strength gains.

Conclusion

This study indicated that there were no significant differences in highly trained Division I football players by using whole body vibration platforms in the strength development for the bench press, the back squat, and the power clean. The implementation of whole body vibration prior to a set of a preferred lift does not help increase a one repetition max in these three lifts. As athletes become stronger and more powerful in training, there may be a direct relationship with performance on the playing field. The question arises if whole body vibration platforms are cost effective in the budget of an athlete and of a training facility. In order to determine if these results are true of other highly trained male athletes, more research needs to be conducted.

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Table 1. Means and Standard Deviations for V1, V2 and C groups in the Bench Press

Group	Pre-Test(lbs)	Mid-Test(lbs)	Post-Test(lbs)
V1	307.50 ± 57.009	314.38 ± 48.949	323.75 ± 49.696
V2	308.57 ± 24.103	318.57 ± 28.094	313.57 ± 23.755
C	290.31 ± 52.169	295.94 ± 49.538	302.19 ± 50.232

Table 2. Means and Standard Deviations for V1, V2 and C groups in the Back Squat

Group	Pre-Test(lbs)	Mid-Test(lbs)	Post-Test(lbs)
V1	412.50 ± 66.494	431.88 ± 49.637	440.63 ± 52.538
V2	381.43 ± 69.144	392.14 ± 61.567	430.00 ± 39.686
C	385.31 ± 68.422	397.19 ± 64.238	405.94 ± 55.324

Table 3. Means and Standard Deviations for V1, V2 and C groups in the Power Clean

Group	Pre-Test(lbs)	Mid-Test(lbs)	Post-Test(lbs)
V1	279.75 ± 54.311	285.50 ± 46.866	310.88 ± 34.353
V2	266.57 ± 41.081	272.71 ± 35.989	296.14 ± 18.106
C	262.44 ± 38.238	269.69 ± 37.441	289.19 ± 36.073

Figure 1: Pre, Mid, and Post Tests Means for the Bench Press for all three Groups.

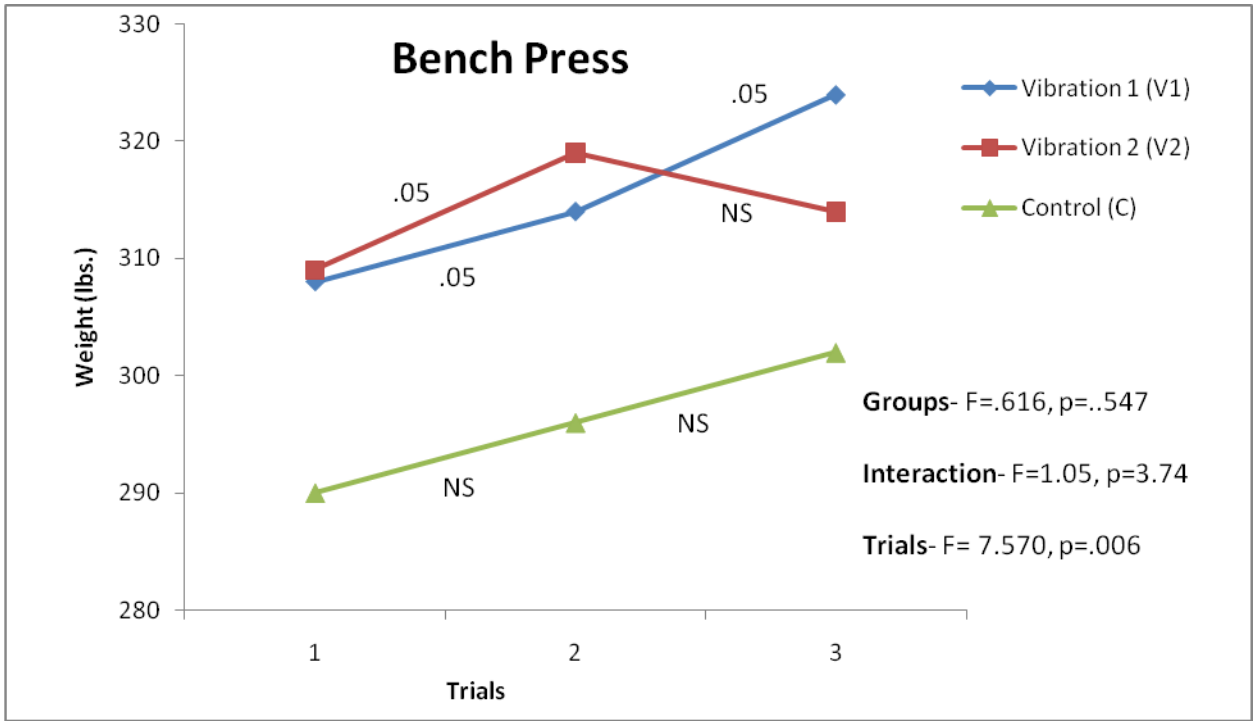

Figure 2: Pre, Mid, and Post Tests Means for the Back Squat for all three Groups.

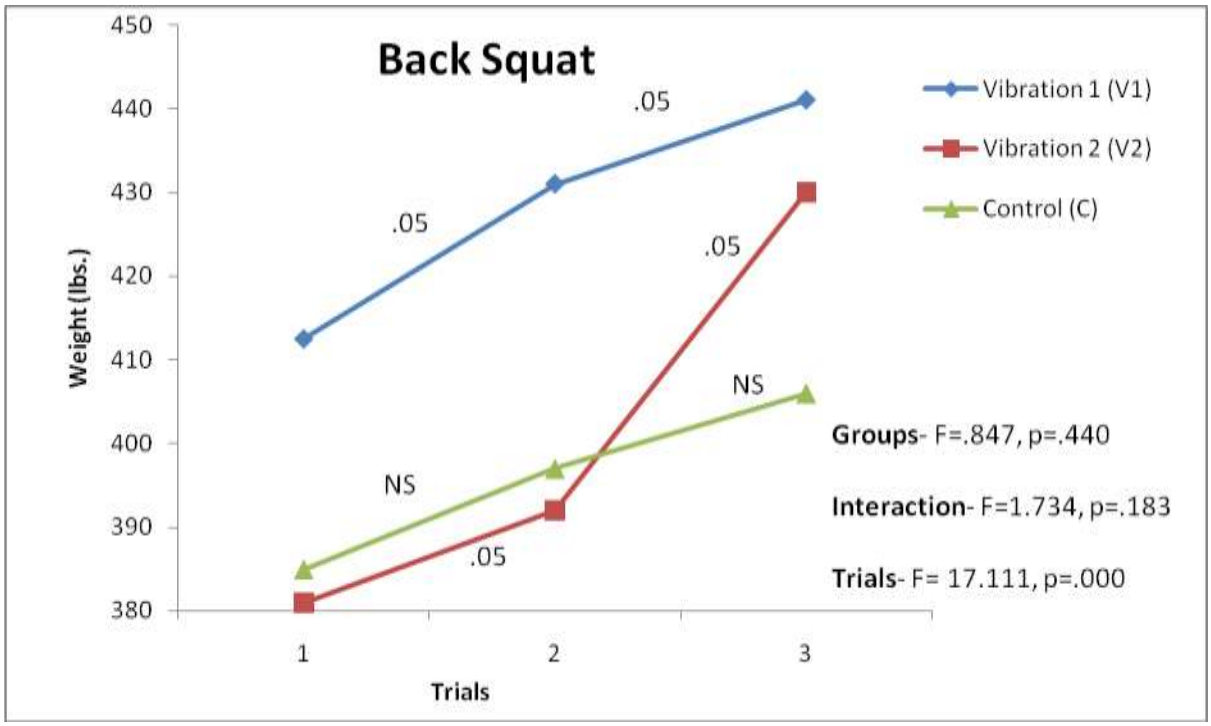

Figure 3: Pre, Mid, and Post Tests Means for the Power Clean for all three Groups.