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Effects of unilateral and bilateral squatting on rotational speed in male and female collegiate golfers

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Effects of Unilateral and Bilateral Squatting on Rotational Speed in Male and Female Collegiate Golfers

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FACULTY COMMITTEE:

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Abstract

Resistance training in combination with plyometrics and medicine ball routines has been shown to improve rotational speed and power. One area that has not been observed has been the difference between bilateral squatting and unilateral squatting on rotational speed. The purpose of the study was to observe the effects of unilateral and bilateral squatting on club head speed in collegiate golfers. Eight male and nine female collegiate golfers were randomly assigned to a unilateral squat group which was the experimental and a bilateral squat group which was the control group and participated in twelve training sessions over the course of four weeks. Club head speed measurements were taken prior to the first training session and after the twelfth training session on a Trackman 4 indoor unit. After the intervention, there were no statistically significant improvements in either group and no statistically significant differences between the unilateral group (pre-training = 100.8 mph ± 12.2 mph, post-training = 100.9 mph ± 12.5 mph) and the control group (pre-training = 102.8 mph ± 11.7 mph, post-training = 103.3 mph ± 12.3 mph). Short duration squat training does not appear to positively impact club head speed in collegiate golfers.

Chapter One

Indicators of Performance

For many strength-power sports, the desired attributes that lead to increased athletic performance are alactic power, vertical jump, and sprint speed (Harries, Lubans, Callister, 2012). Resistance training, plyometric training, and sprint training can improve these attributes (Fatouros et al., 2000). While all of these elements are present in most athletes' training programs, some specific attributes must be addressed given the specific demands of the sport. Sports such as baseball and golf require the ability to produce rotational speed at the end of an implement like a bat or club which is generated at the rotation of the trunk. For the sport of golf a key indicator of performance has been club head speed. Club head speed has shown to be associated with a lower handicap score (Fradkin, Sherman, Finch, 2004). Due to this relationship the training protocol outlined in this study will aim to increase club head speed.

Transverse Movements

For these sports, the ability to generate increased rotational force and power has a direct carryover to improved club speed and performance (Parker, Lagerhem, Hellstrom, Olsson, 2017). Parker et al. observed that performing a standing isokinetic rotation at 1m/s at 10% body weight in combination with a resistance training protocol with pre-elite golfers led to a 78% improvement in carry distance when compared to just performing a resistance training protocol.

In addition to an isokinetic routine, dynamic movements in the transverse plane can also benefit performance and rotational speed and power. For many coaches, the

main way to increase rotational force and power has been to implement rotational medicine ball throws (Earp, Kraemer, 2010). Medicine ball throws over the course of twelve weeks have resulted in a 6.6% increase in dominant- side rotational strength in baseball players when compared to players who did not undergo medicine ball training (Syzmanski et al., 2007). These findings are important as these exercises were performed in addition to an existing training program consisting of traditional exercises such as squats, bench press, and additional nonrotational strength movements. This suggests that a supplementary exercise was able to yield meaningful benefits to rotational strength. In another study performed by Doan et al. on collegiate golfers, the athletes who all underwent an 11 week resistance training and medicine ball program achieved a statistically significant increase in club head speed of 1.6% (Doan et al.,2006). Fletcher and Hartwell found that implementing an eight-week plyometric program as well as medicine ball rotational exercises in combination with the back squat, bench press, and other traditional free weight exercises in golfers yielded a 4.5% increase in carry distance (Fletcher, Hartwell, 2004) compared to a control group that underwent normal training. While these studies all outline a principle that training the transverse plane can improve club head speed not all universities have access to a isokinetic machine or in some cases medicine balls. Therefore this study will omit their use from the program despite their proven effectiveness.

The Effect of Post Activation Potentiation on Club Head Speed

Post-activation potentiation can be understood as an increase in a performance metric due to an exercise being performed prior to the competition event (Lorenz, 2011). Pre-excitation and contraction through maximum voluntary muscular contractions are

theorized to make actin and myosin more sensitive to released calcium leading to greater force in following muscular contractions (Lorenz, 2011). Kilduff et al. observed that rugby athletes performing a three-repetition max back squat experienced an 8% increase in peak power output measured from a counter movement jump (Kilduff et al., 2007). Chatzopoulos et al. found that heavy one rep maxes on back squat increased 10 and 30 meters sprint performance (Chatzpoulos et al., 2007). Read et al. observed that three maximal-effort vertical jumps performed one minute before a golf swing resulted in a 2.2% improvement in club head speed. Furthermore, higher jumps led to larger increases in club head speed (Read, Miller, Turner, 2013). Based on these studies it can be interpreted that there is a possible pathway for resistance training and plyometrics to increase club head speed acutely based on how in the study done by . Kilduff et al. performing back squats led to an increase in peak power output (Kilduff et al., 2007). Since McHardy et al. showed that lower body musculature such as the rectus femoris are used in a golf swing, the effects of this acute increase in peak power output measured through jump height or sprint speed, could have a possible carry-over to a golf swing (McHardy and Pollard, 2005).

Resistance Training and Club Head Speed

Resistance training and plyometric programs can be linked to increases in club head speed even with the removal of transverse plane exercises such as medicine ball throws (Thompson and Osness, and Hetu et al.). Thompson and Osness observed that golfers completing eight weeks of flexibility and strength training increased club head speed by 2.1 miles per hour (Thompson and Osness, 2004). This was in comparison to

the control group that did not participate in resistance training. In addition to the increase in club head speed the group that participated in resistance training also saw statistically significant increases in strength measurments such as leg press, seated row, and lat pull down. This shows that resistance training as well as increasing muscular strength may have beneficial impact on club head speed. In another study, participants who underwent eight weeks of resistance training and plyometrics yielded significant increases in club head speed compared to baseline (Hetu et al., 1998). Similar to Thompson and Ossness the participants in Hetu et al. study showed increase in muscular strength along with the club head speed improvements showing that the two factors are possibly linked. Thus, lower body training and plyometric programs can be linked to increases in rotational speed without the addition of transverse plane exercises. This link is explained by a study done by McHardy and Pollard which observed that various lower body musculature such as the vastus lateralis are activated during a golf swing (McHardy and Pollard, 2005). Since resistance training can be shown to increase the strength of and rate of force development in this muscular there can be possible carryover to greater club head speed (Fatouros et al.,2000)(Eliassen, Saeterbakken,Tillar,2018)(McCurdy, Langofrd, Doscher, Wiley, Mallard, 2005).

Unilateral Vs. Bilateral Training

Unilateral exercises could yield even greater benefits than bilateral training. A six-week unilateral plyometric training program yielded a 19% increase in the sum of single-leg counter-movement jump height and a 36% increase in the rate of force development compared to bilateral plyometrics in college-age males inexperienced to

resistance training (Bogdanis et al., 2017). Similarly, McCurdy et al. found that eight weeks of resistance training and plyometric training that included unilateral squatting resulted in a larger increase in jump height than the same program performed with bilateral squatting (McCurdy, Langford, Doscher, Wiley, Mallard, 2005). Eliassen et al. observed that unilateral squatting led to greater increases in peak vertical force as well as greater barbell velocity (Eliassen, Saeterbakken, Tillar, 2018). An important connection to bring up again is that when performing a golf swing there is activation of lower body musculature to help generate the speed of the club (McHardy and Pollard, 2005). The above studies show how unilateral training can increase peak lower body force (Eliassen, Saeterbakken, Tillar, 2018), lower body rate of force development (Bogdanis, 2017), and lower body power measured with jump height (McCurdy, Langford, Doscher, Wiley, Mallard, 2005), and therefore could possibly cause greater increases in club head speed due to improving these lower body metrics. force.

Research Question

Unilateral strength and plyometric training have been demonstrated to improve rotational force and unilateral strength compared to bilateral training. However, it is unknown if unilateral training is superior to bilateral training for improving movements that rely on rotational speed and power. The purpose of this study will be to compare unilateral squatting and bilateral squatting for improvements in club head speed in collegiate golfers. The hypothesis of this study is that unilateral squatting will lead to greater increases in club head speed than bilateral squatting.

Chapter Two

Sampling:

Eight male and nine female golfers will be recruited from a division 1 NCAA varsity golf team. The participants will be randomly assigned to either a bilateral training group or a unilateral training group evenly so that both intervention groups have an even amount of each sex. Inclusion criteria will be that participants must have experience resistance training for greater than a year and currently participate in one hour of resistance training two to three times per week. Participants must receive and pass the University Sports Physical. Participants must be between 18 and 24 years old.

Before beginning the study, informed consent will be obtained from each participant. This protocol was approved by the James Madison University Institutional Review Board.

Experimental Design:

The study will involve one experimental group (unilateral squatting) and one control group (bilateral squatting). In this case, the intervention will be the implementation of either unilateral or bilateral lower-body resistance training over the course of 12 training sessions performed every Monday, Wednesday, and Friday. The duration of this study is four weeks due to the beginning of the participants competitive season. The day prior to the first training session and the day following the twelfth training session intervention, participants will have club head speed measured to evaluate the effectiveness of the training protocol.

Club head speed:

Club head speed will be evaluated using the TrackMan 4 indoor unit(Scottsdale, Arizona). This eliminates wind resistance and environmental factors that could influence the values. Each participant will complete three swings hitting the ball with their driver. The average peak speed of these measurements will be calculated .

Procedure:

The participants will undergo the following training sessions labeled sessions 1, 2, and 3 with the participants repeating the sequence after every third training session until twelve total sessions have been completed over four weeks. The participants will use a resistance corresponding to a rating perceived exertion (RPE) of 7-8 which will be linked to a certain amount of repetitions short of failure (see Table 4). RPE is a valid estimate of the percent of one repetition maximum in both powerlifters (Helms et al., 2017), as well as novice lifters (Zourdos et al., 2016). Exercises will be done in the order shown in the tables (See table 1, table 2, and table 3) with all sets and repetitions being performed to completion for one exercise before proceeding to the next. Unilateral exercises were instructed by the teams strength and conditioning coach while the bilateral exercises did not require a familiarization session. Training sessions were observed and coached by the teams strength and conditioning coach. Exercise selection was determined by examining what musculature showed activation in a a golf swing in the study performed by McHardy and Pollard 2005. Exercise progression will be organized going from total body movements to smaller isolation movements.

Exercise *Bilateral/Unilateral*	Sets	Repetitions
Barbell Front Squat/Barbell Front Rack Split Squat	3	5 or 5 per leg
Dumbbell Romanian Deadlift	3	10
Single Arm Dumbbell Row	3	10ea
Lat Pulldown	3	10
Band Resisted Pallof Press	3	10 each side
Band Resisted Deadbug	3	10

Table 1: Training session one exercises with sets and repetitions

Exercise *Bilateral/Unilateral*	Sets	Repetitions
Dumbbell Goblet Squat/Dumbbell Goblet Split Squat	3	5 or 5 per leg
Barbell Glute Bridge	3	10
Dumbbell Chest Supported Row	3	10
Front Plank Hold	3	30 seconds
Band Pull Aparts	3	
Half Kneeling Suitcase Holds	3	15 seconds each side

Table 2: Training session two exercises with sets and repetitions

Exercise ***Bilateral/Unilateral***	**Sets**	**Repetitions**
Safety Bar Squat/ Safety Bar Split Squat	**3**	**5 or 5 per leg**
Single Leg Hip Bridge	**3**	**10 each leg**
Landmine Row	**3**	**10 each arm**
Kneeling X Band Pulldown	**3**	**10**
Side Plank Hold	**3**	**30 seconds each side**
Half Kneeling Pallof Hold	**3**	**15 seconds each side**

Table 3: Training session three exercises with sets and repetitions

RPE Score	RPE definition
10	**No repetitions in reserve**
9	**One repetition in reserve**
8	**Two repetitions in reserve**
7	**Three repetitions in reserve**
6	**Four repetitions in reserve**
5	**Five repetitions in reserve**
4	**Light exertion**
3	**Light exertion**
2	**Little if any exertion**
1	**Little if any exertion**

Table 4: RPE scale and definitions

Statistical Analysis:

A two-way repeated measures ANOVA will be performed with training (pre, post) as the within-subjects factor and group (unilateral, bilateral) as the between-subjects factor. Post-hoc testing will be performed using t-tests and Bonferroni correction. Significance will be set at $p < 0.05$.

Chapter Three

Introduction:

One facet of improving golf performance is to increase the club head speed as greater speed combined with proper contact will lead to a greater carry distance. This relationship can be observed by noting that club head speed has been proven to be an accurate predictor of golf performance (Fradkin, Sherman, Finch, 2004). In the study performed by Fradkin et al. on golfers between 18 and 20 years old, those with a higher club head speed had a lower handicap, meaning a greater performance and skill level. While the swing technique is important, strength training can also fulfill an important role in increasing performance. It has been shown that strength training programs successfully increase club head speed (Fletcher and Hartwell 2004)(Thompson and Osness, 2004)(Syzmanski et al. 2007). It has also been shown that programs that combine rotational movements, such as medicine ball throws or isokinetic roations, with traditional barbell exercises have improved club head speed (Syzmanski et al., 2007)(Parker et al., 2017). Improvements have also been observed in programs that have used barbell or machine strength training exercises (Thompson and Osness, 2004)(Hetu et al., 1998). These programs included a variety of resistance training exercises including barbell squats, lunges, and row variations. Prior research has suggested that unilateral training may be superior in developing rate of force development, unilateral jump height, and peak isometric force than bilateral training (Bogdanis et al., 2019)(McCurdy et al., 2005)(Eliassen, Saeterbakken, Tillar, 2018). A study done by McHardy and Pollard noted levels of lower body muscle activation up to 88% of maximum voluntary contraction occur during a golf swing (McHardy and Pollard, 2005). Since the studies done by

Bogdanis et al, McCurdy et al., and Eliassen et al., point that unilateral training is superior in improving rate of force development it is hypothesized that unilateral training will increase club head speed to a greater degree than bilateral training. It has been observed that resistance training and plyometrics can improve club head speed and if either bilateral or unilateral squatting proves superior it would give coaches an easily actionable tool to improve club head speed. The purpose of this study was to determine the effectiveness of unilateral and bilateral lower-body resistance training on club head speed in Division 1 NCAA golfers.

Methods

Sampling:

Eight male and nine female golfers aged 20.4 ± 1.5, height 174.7 cm. ± 12.11 cm, male pre-intervention club head speed (114.2 mph ± 2.5 mph), female pre-intervention club head speed (90.7 ± 2.9 mph), were recruited from a division 1 NCAA varsity golf team. The participants were randomly assigned to either the bilateral training group (four male, four female) or the unilateral training group (four male, five female). Inclusion criteria were as follows, Participants had resistance training experience of at least a year and participated in one hour of resistance training two to three times per week. Participants had received and passed the University Sports Physical. Participants were between the ages of 18-24. Before beginning the study informed consent was obtained from each participant. This protocol was approved by the James Madison University Institutional Review Board.

Experimental Design:

The intervention was the implementation of either unilateral or bilateral lower-body resistance training over the course of the 12 training sessions performed every Monday, Wednesday, and Friday. The day prior to the first training session and the day following the twelfth training session intervention, participants had club head speed measured to evaluate the effectiveness of the training protocol.

Club head speed was evaluated using the Trackman 4 indoor unit. This eliminates wind resistance and environmental factors that could influence the values. Each participant completed three swings with their driver. The average of these measurements was calculated to determine the average club head speed of the three swings throughout the swing.

Procedure:

The participants underwent the following training sessions labeled sessions 1, 2, and 3 with the participants repeating the sequence after every third training session until twelve total sessions had been completed over four weeks. The participants used a resistance corresponding to a rating perceived exertion (RPE) of 7-8 which was linked to a certain amount of repetitions short of failure (see Table 4). RPE is a valid estimate of the percent of one repetition maximum in both powerlifters (Helms et al., 2017), as well as novice lifters (Zourdos et al., 2016). Exercises were done in the order they are shown in the table with all sets and repetitions being performed to completion for one exercise before participants proceeded to the next. Exercise progressions were organized going from total body movements to smaller isolation movements.

Exercise Bilateral/Unilateral	**Sets**	**Repetitions**
Barbell Front Squat/ Barbell Front Rack Split Squat	**3**	**5 or 5 per leg**
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Lat Pulldown	**3**	**10**
Band Resisted Pallof Press	**3**	**10 each side**
Band Resisted Deadbug	**3**	**10**

Table 1: Training session one exercises with sets and repetitions

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Dumbbell Chest Supported Row	**3**	**10**
Front Plank Hold	**3**	**30 seconds**
Band Pull Aparts	**3**	
Half Kneeling Suitcase Holds	**3**	**15 seconds each side**

Table 2: Training session two exercises with sets and repetitions

Exercise Bilateral/Unilateral	**Sets**	**Repetitions**
Safety Bar Squat/ Safety Bar Split Squat	**3**	**5 or 5 per leg**
Single Leg Hip Bridge	**3**	**10 each leg**
Landmine Row	**3**	**10 each arm**
Kneeling X Band Pulldown	**3**	**10**
Side Plank Hold	**3**	**30 seconds each side**
Half Kneeling Pallof Hold	**3**	**15 seconds each side**

Table 3: Training session three exercises with sets and repetitions

RPE Score	RPE definition
10	**No repetitions in reserve**
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6	**Four repetitions in reserve**
5	**Five repetitions in reserve**
4	**Light exertion**
3	**Light exertion**
2	**Little if any exertion**
1	**Little if any exertion**

Table 4: RPE scale and definitions

Statistical Analysis:

A two-way repeated measures ANOVA was performed with training (pre, post) as the within-subjects factor and group (unilateral, bilateral) as the between-subjects factor. Significance was set at $p < 0.05$.

Results:

As shown in Figure 1, there was no significant difference ($P > 0.05$) between pre-intervention club head speed and post-intervention club head speed for both unilateral (pre-training = 100.8 mph ±12.2 mph, post training = 100.9 mph ± 12.5 mph) and bilateral (pre-training = 102.8 mph ± 11.7 mph, post-training = 103.3 mph ± 12.3 mph) groups. When looked at by sex neither females nor males showed any statistically

significant improvement in club head speed. Females unilateral (pre-training = 90.1 mph ± 1.6 mph , post-training = 89.9 mph ±1.6 mph) and bilateral (pre-training = 91.6 mph ± 3.9 mph , post-training = 91.4 mph ± 3.4 mph). Males unilateral (pre-training = 114.3 mph ± 2.4 mph, post-training 114.8 mph = ± 1.7 mph) and bilateral (pre-training = 114.0 mph ± 2.7 mph, post-training= 115.2 mph ± 2.4 mph)

Subject Number	**Sex**	**Group**	**Pre Intervention Club Head Speed MPH**	**Post Intervention Club Head Speed MPH**	**Tonnage lbs**
1	M	Bilateral	118.4	118.7	23100
2	M	Bilateral	111.3	112.2	25350
5	M	Bilateral	113.5	115.7	
6	M	Bilateral	112.9	114.3	22425
10	F	Bilateral	88.3	88.5	12300
12	F	Bilateral	97.4	96.5	14250
13	F	Bilateral	93.2	92.5	13500
17	F	Bilateral	87.5	88.1	14175
3	M	Unilateral	118.4	116.9	17700
4	M	Unilateral	113.1	114.3	20850
7	M	Unilateral	112.3	112.2	15825
8	M	Unilateral	113.4	115.7	16050
9	F	Unilateral	88.7	89.8	10950
11	F	Unilateral	89.7	89.2	10800
14	F	Unilateral	91.6	91.5	11400
15	F	Unilateral	92.2	91.7	10050
16	F	Unilateral	88.3	87.2	9825

Table 5: Individual club head speed improvements compared to tonnage

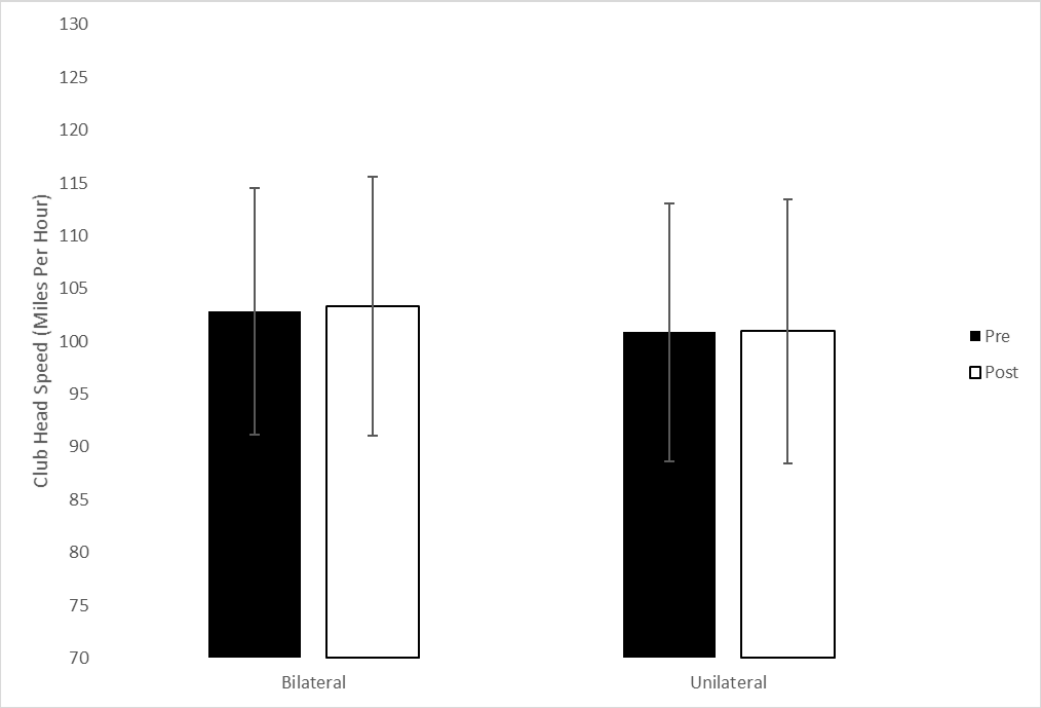
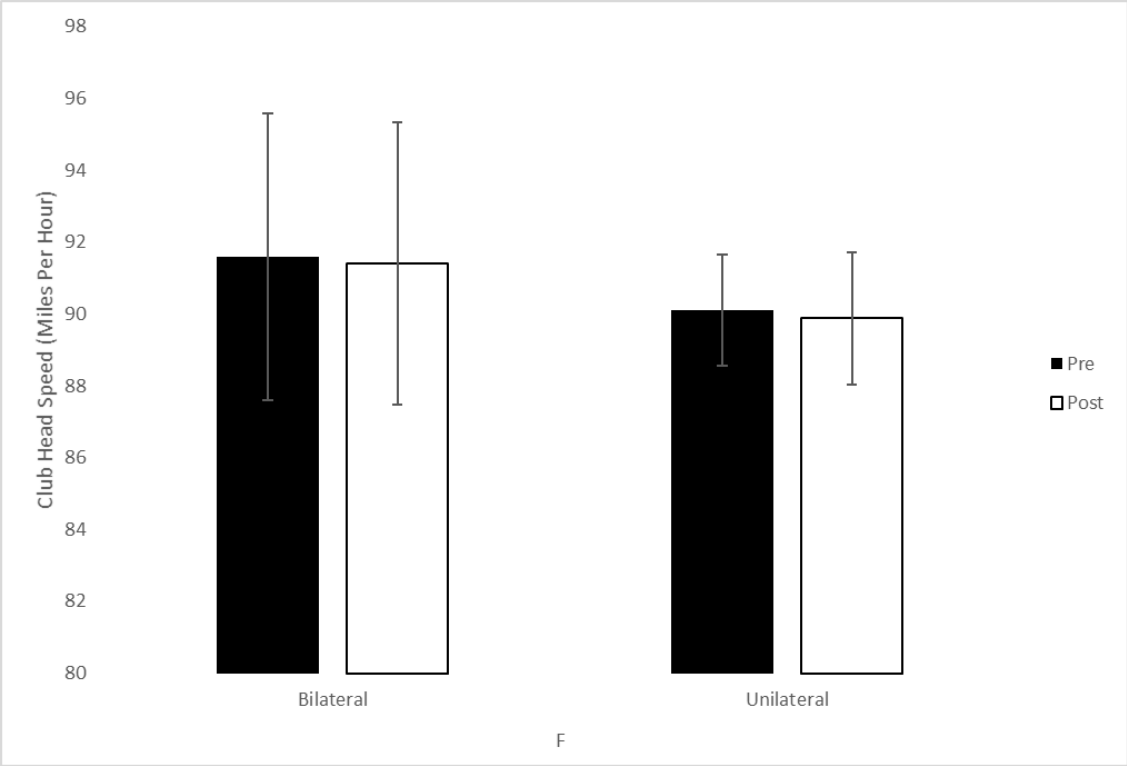


Figure 1: Average golf club head speed of male and female collegiate golfers following a four-week training intervention comparing bilateral and inilateral squats.



Figue 2: Average golf club head speed of female collegiate golfers following a four-week training intervention comparing bilateral and unilateral squats.

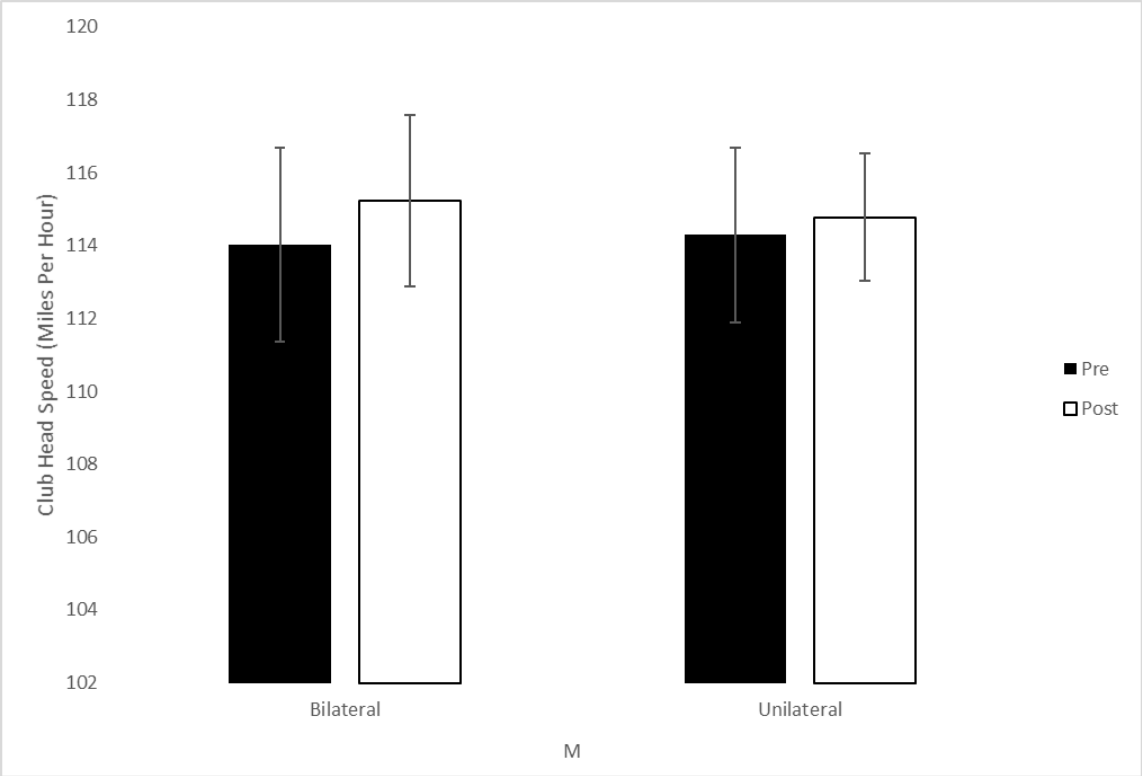


Figure 3: Average golf club head speed of male collegiate golfers following a four-week training intervention comparing bilateral and unilateral squats.

Discussion:

The purpose of this study was to compare unilateral or bilateral squatting in improvements to club head speed in collegiate golfers. Neither group showed significant improvement in club head speed after the twelve-session intervention. There was however an unintended finding. While not statistically different a lower training tonnage in the unilateral group was able to maintain their rotational speed throughout the duration of the study. This provides a possible training modality to be used as a way to maintain a key performance indicator while not requiring as great of a tonnage. The lack of rotational speed improvement does conflict with the majority of previous research on the subject. Fletcher et al. found that an eight-week resistance and plyometric training

program increased club head speed by 1.5% using both bilateral squats and unilateral lower body exercises such as a lunge (Fletcher et al. 2004). A possible reason for this difference in results could be explained by the duration of the intervention. The present study was half of that utilized in the aforementioned study by Fletcher et al. In addition to the duration the fact that Fletcher et al. included plyometrics but this study did not brings up the possibility that plyometrics could be a necessary component for improving club head speed. This is in agreement with the study performed by Hetu et al. in the sense that Hetu et al. also used a combination program of both resistance training in addition to plyometric (Hetu et al., 1998). Again this study points out the possible necessity of both to elicit an increase in club head speed. Another possible lack of findings in this study is the removal of transverse plane exercises. Doan et al. which found that collegiate golfers undergoing an eleven-week resistance training and medicine ball routine significantly increase in club head speed when compared to baseline (Doan et al., 2006). In addition to the difference in duration of the program, Doan et al.'s study utilized medicine ball routines. Rotational training was specifically avoided in the present study as we were trying to observe the effects of unilateral squatting without any exercises confounding these specific effects. Thompson and Osness observed that an eight-week combined flexibility and resistance training program increased club head speed in individuals aged 55-79 (Thompson, Osness, 2004). A unique aspect of that study was the inclusion of a flexibility protocol designed to increase mobility at the hip and trunk. This greater range of motion to build speed could have possibly been the reason that the study done by Thompson and Osness saw a significant increase in club head speed . Thus, the lack of a

periodized and sport specific flexibility protocol could be a reason for why this study did not yield an improvement in club head speed.

A limitation of the current study is the duration of the intervention. Therefore, it is possible that the duration of the training intervention needs to exceed four weeks to significantly increase club head speed for either bilateral or unilateral training. However, the current findings do suggest that a short-term intervention does not lead to increases in club head speed. Thus, coaches may need to structure longer-term interventions into their schedules to incorporate positive improvements in club head speed. Another limitation is the difference in practice schedules undergone by various participants. Since the participants are collegiate athletes, their coaches had them perform practice routines specific to their skill deficiencies. This means that some participants underwent different practice schedules than others with some spending more time at the driving range in comparison to other activities such as putting, adding a confounding factor to the study. However, this is standard practice for golf teams and this challenge will not be unique to any strength and conditioning coach who is attempting to create effective interventions for golf teams.

In conclusion, it seems that neither bilateral or unilateral squatting improve club head speed following a short-term squat intervention. Future research should include longer duration training interventions as well as a combination approach involving rotation training with traditional strength training movements.

Manuscript References

Bogdanis, G., Tsoukos, A., Kaloheri, O., Terzis, G., Veligekas, P., & Brown, L. (2017). Comparison between Unilateral and Bilateral Plyometric Training on Single and Double Leg Jumping Performance and Strength. *Journal of Strength and Conditioning Research, 33*(3), 633-640.

Doan, B., Newton, R., Kwon, Y.-H., & Kraemer, W. (2006). Effects of Physical Conditioning on Intercollegiate Golfer Performance. *Journal of Strength and Conditioning Research, 20*(1), 62-72.

Eliassen, W., Saeterbakken, A., & van den Tillaar, R. (2018). Comparison of Bilateral and Unilateral Squat Exercises on Barbell Kinematics and Muscle Activation. *International Journal of Sports Physical Therapy, 13*(5), 871.

Fletcher, I., & Hartwell, M. (2004). Effect of an 8-week combined weights and plyometrics training program on golf drive performance. *Journal of Strength and Conditioning Research*.

Fradkin, A., Sherman, C., & Finch, C. (2004). How Well Does Club Head Speed Correlate With Golf Handicaps? *Journal of Science and Medicine in Sport, 7*(4), 465-472.

Helms, E., Storey, A., Cross, M., Brown, S., Lenetsky, S., Ramsay, H., . . . Zourdos, M. (2017). RPE and Velocity Relationships For The Back Squat, Bench Press, and Deadlift in Powerlifters. *Journal of Strength and Conditioning Research, 31*(2), 292-297.

Hetu FE, Christie CA, & Faigenbaum AD. (1998). Effects of Conditioning On Physical Fitness and Club Head Speed In Mature Golfers. *Perceptual and Motor Skills, 3*(1), 811.

Mccurdy, K., Langford, G., Doscher, M., Wiley, L., & Mallard, K. (2005). The Effects of Short-Term Unilateral and Bilateral Lower-Body Resistance Training on Measures of Strength and Power. *Journal of Strength and Conditioning Research, 19*(1), 9-15.

McHardy, A., & Pollard, H. (2005, 11). Muscle Activity During the Golf Swing. *British Journal of Sports Medicine, 39(11),* 799-804.

Parker, J., Lagerhem, C., Hellström, J., & Olsson, M. (2017). Effects of nine weeks isokinetic training on power, golf kinematics, and driver performance in pre-elite golfers. *BMC Sports Science, Medicine and Rehabilitation, 9*(21).

Szymanski, D., Bradford, T., Schade, R., Szymanski, J., & Pascoe, D. (2010). Effect of 12 Weeks of Medicine Ball Training on High School Baseball Players. *Medicine & Science in Sports & Exercise*.

Thompson, C., & Osness, W. (2004). Effects of an 8-Week Multimodal Exercise Program on Strength, Flexibility, and Golf Performance in 55-to 79-Year-Old Men. *Journal of Aging and Physical Activity, 11*, 144-156.

Zourdos, M., Klemp, A., Dolan, C., Quiles, J., Schau, K., Jo, E., . . . Blanco, R. (2016). Novel Resistance Training-Specific Rating of Perceived Exertion Scale Measuring Repetitions in Reserve. *Journal of Strength and Conditioning Research, 30*(1), 267-275.

Consent to Participate in Research

Identification of Investigators & Purpose of Study

You are being asked to participate in a research study conducted by *Emmett Van Der Snick* from James Madison University. The purpose of this study is to identify whether single leg or double leg squatting is more beneficial for improving rotational speed. This study will contribute to the researcher's completion of his masters thesis.

Research Procedures

Should you decide to participate in this research study, you will be asked to sign this consent form once all your questions have been answered to your satisfaction. This study consists of a resistance training program that will be administered to individual participants in the James Madison University Athletic Performance Center.

Time Required

Participation in this study will require 15 hours of your time over the course of twelve training sessions for an hour each and two measurement sessions.

Risks

The investigator does not perceive more than minimal risks from your involvement in this study (that is, no risks beyond the risks associated with everyday life).

Benefits

Potential benefits from participation in this study include an increase in rotational speed and an increase in athletic performance.

Confidentiality

The results of this research will be presented at a graduate thesis panel. The results of this project will be coded in such a way that the respondent's identity will not be attached to the final form of this study. The researcher retains the right to use and publish non-identifiable data. While individual responses are confidential, aggregate data will be presented representing averages or generalizations about the responses as a whole. All data will be stored in a secure location accessible only to the researcher. Upon completion of the study, all information that matches up individual respondents with their answers will be destroyed.

Participation & Withdrawal

Your participation is entirely voluntary. You are free to choose not to participate. Should you choose to participate, you can withdraw at any time without consequences of any kind.

Questions about the Study

If you have questions or concerns during the time of your participation in this study, or after its completion or you would like to receive a copy of the final aggregate results of this study, please contact:

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Questions about Your Rights as a Research Subject

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Giving of Consent

I have read this consent form and I understand what is being requested of me as a participant in this study. I freely consent to participate. I have been given satisfactory answers to my questions. The investigator provided me with a copy of this form. I certify that I am at least 18 years of age.

_____
Name of Participant (Printed)

_____ _____
Name of Participant (Signed) Date

_____ _____
Name of Researcher (Signed) Date

References

Bogdanis, G., Tsoukos, A., Kaloheri, O., Terzis, G., Veligekas, P., & Brown, L. (2017). Comparison between Unilateral and Bilateral Plyometric Training on Single and Double Leg Jumping Performance and Strength. *Journal of Strength and Conditioning Research, 33*(3), 633-640.

Chatzopoulos, D., Michailidis, C., Giannakos, A., Alexiou, K., Patikas, D., Antonopoulos, C., . . . Antonopoulos, C. (2007). Postactivation Potentiation Effects After Heavy Resistance Exercise on Running Speed. *Journal of Strength and Conditioning Research, 21*(4), 1278-1281.

Doan, B., Newton, R., Kwon, Y.-H., & Kraemer, W. (2006). Effects of Physical Conditioning on Intercollegiate Golfer Performance. *Journal of Strength and Conditioning Research, 20*(1), 62-72.

Earp, J., & Kraemer, W. (2010). Medicine Ball Training Implications for Rotational Power Sports. *Journal of Strength and Conditioning Research, 32*(4), 20-25.

Eliassen, W., Saeterbakken, A., & van den Tillaar, R. (2018). Comparison of Bilateral and Unilateral Squat Exercises on Barbell Kinematics and Muscle Activation. *International Journal of Sports Physical Therapy, 13*(5), 871.

Fatouros, I., Jamurtas, A., Leontsini, D., Taxildaris, K., Aggelousis, N., Kostopoulos, N., & Buckenmeyer, P. (2000). Evaluation of Plyometric Exercise Training, Weight Training, and Their Combination on Vertical Jumping Performance and Leg Strength. *Journal of Strength and Conditioning Research, 14*(4), 470-476.

Fletcher, I., & Hartwell, M. (2004). Effect of an 8-week combined weights and plyometrics training program on golf drive performance. *Journal of Strength and Conditioning Research*.

Fradkin, A., Sherman, C., & Finch, C. (2004). How Well Does Club Head Speed Correlate With Golf Handicaps? *Journal of Science and Medicine in Sport, 7*(4), 465-472.

Harries, S., Lubans, D., & Callister, R. (2012). Resistance Training to Improve Power and Sports Performance in Adolescent Athletes: A Systematic Review and Meta-Analysis. *Journal of Science and Medicine in Sport, 15*(1), 532-540.

Helms, E., Storey, A., Cross, M., Brown, S., Lenetsky, S., Ramsay, H., . . . Zourdos, M. (2017). RPE and Velocity Relationships For The Back Squat, Bench Press, and Deadlift in Powerlifters. *Journal of Strength and Conditioning Research, 31*(2), 292-297.

Hetu FE, Christie CA, & Faigenbaum AD. (1998). Effects of Conditioning On Physical Fitness and Club Head Speed In Mature Golfers. *Perceptual and Motor Skills, 3*(1), 811.

Kilduff, L., Bevan, H., Kingsley, M., Owen, N., Bennett, M., Bunce, P., . . . Cunningham, D. (2007, 11). Postactivation potentiation in professional rugby players: Optimal recovery. *Journal of Strength and Conditioning Research, 21*(4), 1134-1138.

Lorenz, D. (2011). Postactivation Potentiation: An Introduction. *The International Journal Of Sports Physical Therapy, 6*(3), 234.

Mccurdy, K., Langford, G., Doscher, M., Wiley, L., & Mallard, K. (2005). The Effects of Short-Term Unilateral and Bilateral Lower-Body Resistance Training on

Measures of Strength and Power. *Journal of Strength and Conditioning Research, 19*(1), 9-15.

McHardy, A., & Pollard, H. (2005, 11). Muscle Activity During the Golf Swing. *British Journal of Sports Medicine, 39(11),* 799-804.

Parker, J., Lagerhem, C., Hellström, J., & Olsson, M. (2017). Effects of nine weeks isokinetic training on power, golf kinematics, and driver performance in pre-elite golfers. *BMC Sports Science, Medicine and Rehabilitation, 9*(21).

Read, P., Miller, S., & Turner, A. (2013). The Effects of Postactivation Potentiation on Golf Club Head Speed. *Journal of Strength and Conditioning Research, 27*(6), 1579-1582.

Szymanski, D., Bradford, T., Schade, R., Szymanski, J., & Pascoe, D. (2010). Effect of 12 Weeks of Medicine Ball Training on High School Baseball Players. *Medicine & Science in Sports & Exercise*.

Thompson, C., & Osness, W. (2004). Effects of an 8-Week Multimodal Exercise Program on Strength, Flexibility, and Golf Performance in 55-to 79-Year-Old Men. *Journal of Aging and Physical Activity, 11,* 144-156.

Zourdos, M., Klemp, A., Dolan, C., Quiles, J., Schau, K., Jo, E., . . . Blanco, R. (2016). Novel Resistance Training-Specific Rating of Perceived Exertion Scale Measuring Repetitions in Reserve. *Journal of Strength and Conditioning Research, 30*(1), 267-275.