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Hex-Bar Deadlift as a Post Activation Performance Enhancement Warm-up Strategy for Golf Club Head Speed

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ABSTRACT

Club head speed (CHS) is a key determinate of golf ball carry distance. Greater carry distance correlates with greater skill. The aim of the present study is to investigate the acute effects of using the hex - bar deadlift as a post activation potentiation enhancement for improving CHS in collegiate golfers. Sixteen (n= 8 females, age: 19.5 ± 2 years, weight 68.66 kg ± 8.6kg, height 168.4 cm ± 12.7 cm, n=8 males, age: 19.75 ± 2 years, weight 70.0 kg ± 9.5kg, height 178.1 cm ± 12.7 cm) division 2 collegiate golfers participated in this randomized crossover study during the off-season. The study was divided into 3 sessions on 3 separate days. Players reported to the training facility and completed a one-repetition maximum (1RM) hex-bar deadlift on day one. Sessions 2 and 3 included two CHS assessments, one with the PAPE protocol and one without. Each session was 5-7 days apart. One CHS test was preceded by a standardized warm-up, while the other was preceded by the same standardized warm-up with the inclusion of the hex - bar deadlift PAPE strategy (3 reps at 60%, 3 reps at 70%, and 3 reps at 85% of 1RM). A paired two-sided t-test revealed an increase in CHS with the PAPE strategy resulting in a mean difference in CHS of +0.8325 mph (p = 0.02447, d = 0.625). In conclusion, the hex- bar deadlift was shown to provide enough stimulus to elicit a PAPE effect and increase CHS in collegiate golfers.

Keywords: Golf Science, Strength Training, Power Production, Intervention, Skill-based sport

INTRODUCTION

Club head speed (CHS) has been positively correlated with performance in golfers (19). The higher CHS a golfer demonstrates, the further they drive the golf ball (19). Increases in CHS as small as 1 mph have been shown to increase golf ball distance by 2.84 yards (20). During a competitive round of golf, a 1 mph difference in CHS could be the difference between hitting over a sand trap or a pond by 2-3 yards (13). Therefore, a golfer's CHS plays an important role in decision-making on the course and gives players a competitive advantage with increased speed and distance. A primary contributor to CHS is the golfer's ability to use their lower body to create force, especially among elite golfers under 30 years of age (15). Full body warm-up and workout routines are common for elite golfers to perform before playing a round of golf (26). The warm-up is a routine that prepares the body for physical exertion and is an important part of optimizing athletic performance. The warm-up can be adjusted to enhance different physiological elements through varied intensities, volumes, or types of exercise (1). A warm-up protocol known as the RAMP (Raise, Activate, Mobilize, Potentiate) protocol consists of performing activities with progressive sport-specificity and intensity (11). The final step in the RAMP protocol (Potentiate) is intended to elicit improved performance in the subsequent sport activity, or post-activation performance enhancement (PAPE) (8,11). Performance enhancement is thought to be achieved through post-activation potentiation (PAP) (i.e., improved muscular performance due to recent muscle contraction history) (8,11). PAP is elicited following maximal, or near maximal contractions leading to improved muscular performance in type II muscle fibers (17,19). Type II muscle fibers are found in high threshold motor units and require high levels of force production or neural drive for them to be activated (5). Increasing activation of high threshold motor units is especially beneficial for promoting performance of activities requiring speed, strength, and power such as the golf swing.

PAPEs can be used to enhance chronic adaptations in training or alternatively used within a warm-up to acutely enhance a skill, such as the golf swing. Previous research has investigated PAPE strategies for increasing CHS. Bliss et al., (6) examined the use of speed sticks as an overspeed potentiated warm-up strategy and reported significant PAPE of CHS in the experimental group compared to the control group (110.1 ± 5.5 mph vs 111.6 ± 5.1 mph, p = 0.004, ES= 0.28) (5). Additionally, Read et al., (21) used a countermovement jump as their strategy to induce a PAPE effect. This study examined a 2.25 mph average increase in CHS with this strategy (ES = 0.16, $p < 0.05$) (19). Both strategies were used to acutely activate type II muscle fibers in the lower body to enhance the speed of swinging a golf club.

In the present study, the goal was to assess the effectiveness of a hex-bar deadlift PAPE strategy on golf CHS. The hex–bar deadlift is a common exercise used by strength and conditioning coaches that elicits high ground reaction forces and stimulates the posterior chain to activate and strengthen muscles of the back and lower limbs (1). Compared to the traditional straight bar deadlift, the hex-bar deadlift is theorized to reduce stress on the lumbar spine (26). The golfers who participated in this study were familiar with performing the hex-bar deadlift from golf strength training workouts. Golfers who generate greater maximal ground reaction force tend to produce greater CHS (10). The muscles of the lower extremities, hips, and low back are important in the execution of the golf swing and these same muscles are activated during the execution of a deadlift (1,15). Performed chronically, traditional strength training with heavy loads (80-90% of 1RM) for (4-8 repetitions) has been shown to improve an athlete's strength and power when executing movements with lighter loads (1). Performed acutely, heavy loads have been shown to elicit a PAPE effect (1). Altogether, loads around 85% of 1RM are recommended for power increases in short term scenarios (1,16). We hypothesized that the PAPE strategy using a hex-bar deadlift would increase CHS.

METHODS

Participants

Sixteen healthy collegiate golfers (n= 8 females, age: 19.5 ± 2 years, mass 68.7 kg ± 8.6kg, height 168.4 cm ± 12.7 cm, 1RM Hex-bar deadlift = 102.86 + 17.5 kg, n=8 males, age: 19.75 ± 2 years, mass 70.0 kg ± 9.5kg, height 178.1 cm ± 12.7 cm, 1RM Hex-bar deadlift = 158.82 + 16.14 kg) participated in this off-season randomized crossover study. All Participants were injury free for the last 6 months and did not have any other conditions that would negatively affect the performance of strength training. Participants were not permitted to consume any alcohol or drugs that may alter motor performance within 24 hours of any study session.

All participants completed an informed consent, the Physical Activity Readiness Questionnaire (PAR-Q), and Health History questionnaire to screen for the presence of exclusion criteria. At the time of the study, all participants were completing non-study related supervised 1-hour strength training sessions 3 times per week and participating in 2-hour off-season golf practices 6 days per week.

Protocol

The aim of this study was to investigate the acute effect of hex-bar deadlifts as a PAPE strategy to increase CHS in golfers. The study was divided into 3 sessions. The first session included a 1-RM Hex-Bar deadlift assessment followed by randomization and counterbalancing of participants into two groups. Sessions 2 and 3 either included a CHS analysis using the Trackman 4 Launch Monitor with the PAPE protocol or without the PAPE protocol (CON). Five to seven days after the first session, group 1 performed the non-PAPE warm-up and CHS analysis while group 2 performed the PAPE warm-up and CHS analysis. Five to seven days after session 2, group 1 performed the PAPE warm-up and CHS analysis while group 2 performed the non-PAPE warm-up and CHS analysis. Figure 1 displays the methodology timeline.

Session 1

A warm-up and 1-RM assessment were performed in the weight training facility on the college campus.

Each participant performed 3 minutes of cycling on a stationary bike, the Functional Resistance (FR) warmup with a resistance band, followed by an Active Dynamic (AD) warmup with a weighted swing speed stick, a sand wedge, an 8-iron, 4-iron, fairway wood, and driver (27).

Functional resistance warm-up (FR)

1. Band resisted rotational trunk movement in standing × 10 bilat
2. Band resisted standing lunge and rotational trunk movement × 10 bilat
3. Band resisted right arm cross chest adduction and internal rotation × 10
4. Band resisted left arm external rotation and shoulder abduction × 10
5. Band resisted wood chop from right and left trunk rotation × 10

Active Dynamic Warmup (AD)

6. Ten practice swings with weighted club
7. Three full-swing shots with sand wedge
8. Three full-swing shots with 8-iron
9. Three full-swing shots with 4-iron
10. Three full-swing shots with fairway metal wood
11. Three full-swing shots with driver

Next, a 1-RM deadlift assessment was completed utilizing the National Strength and Conditioning Association (NSCA) 1-RM deadlift protocol. The protocol is clearly outlined in the NSCA Essentials of Strength and Conditioning (8). The 1-RM values were used to calculate 60%, 70%, and 85% 1-RM for use during the PAPE session. Participants were then randomized and counterbalanced into two groups to minimize the effect of current training schedules. Each participant acted as their own control (CON).

Session 2 and 3 included the same warm-up procedures as session 1.

In the second session, group 1 performed the warm-up with the PAPE (1 set of 3 reps at 60%

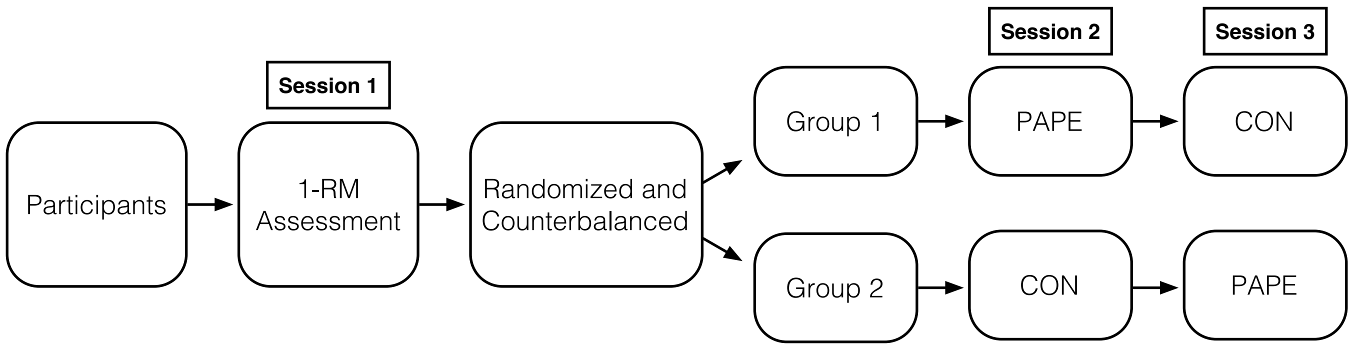

Figure 1. Diagram of study procedures

Figure 2. PAPE Strategy, Hex Bar Deadlift.

Figure 3. Swing Speed Analysis.

1-RM, 70% 1-RM and 85% 1-RM with 90 second interval rest in between sets) where participants were told to perform the deadlift as fast as possible (18). After the PAPE protocol, participants rested for 15 minutes per recommendation from Sue et al., (2). The CHS analysis was conducted in a separate location from the hex-bar protocol. The 15-minute rest period allowed enough time to get from the weight training facility to the golf facility.

During the CHS analysis, participants were blinded to their CHS values and instructed to disregard the accuracy of their swing. Five maximal speed driver swings were performed with 20 seconds rest between swings. The Trackman 4 Launch Monitor analyzed the CHS, and the average CHS was used for analysis. Group 2 performed the warm-up without the PAPE followed by a 15-minute rest and the same CHS analysis.

In the third session, group 1 performed the non-PAPE warm-up and group 2 performed the PAPE warm-up followed by the same 15-minute rest and CHS analysis.

Measurements of CHS data were determined using the TrackMan 4 Launch Monitor (3). CHS is determined by the speed of the club as it comes in contact with the golf ball. TrackMan 4 uses radar beams that reflect off moving objects within its range of sight (13). The clubhead and the ball are tracked by radars to gather various data including CHS, ball speed, launch angles, and more. Doppler radars have been proven to be a reliable source of measurement through comparisons with high-speed camera data (4,14,24). All procedures were approved by the Institutional Review Board approval # 2023ER045.

Statistical Analysis

R-Studio for Mac (version 2023.12.1+402) was used to conduct a paired t-test to determine if the mean difference of the average swing speeds were different between the control and intervention trials. Based on estimated effect sizes from Bliss et al., (6), power was analyzed a priori using G*Power (version 3.1.9.4), which indicated a critical n of 12 golfers would achieve 0.80 power at 0.05 alpha level (6). Effect sizes (Cohen's d_z) were calculated as the mean difference score between paired post- and pre-intervention swing speeds divided by the standard deviation of the differences between paired swing speeds (13). Effect sizes were interpreted as ≥ 0.2 = small, ≥ 0.5 = medium, and ≥ 0.8 = large (25). Parametric test assumptions were verified using visual analysis and Shapiro-Wilk test. Paired t-tests were used to determine differences between gender and CHS. Lastly, an ANOVA was performed to observe the effect of strength on change in CHS with the PAPE.

Table 1. Statistical Comparison Between Control and PAPE

Control CHS	PAPE CHS	% Difference	*p*-value	Effect size (Cohen's D)
M = 103.7, SD = 14.3, 95% CI [96.7, 110.7]	M = 104.6, SD = 13.8, 95% CI [97.8, 111.4]	0.87	0.02	0.63

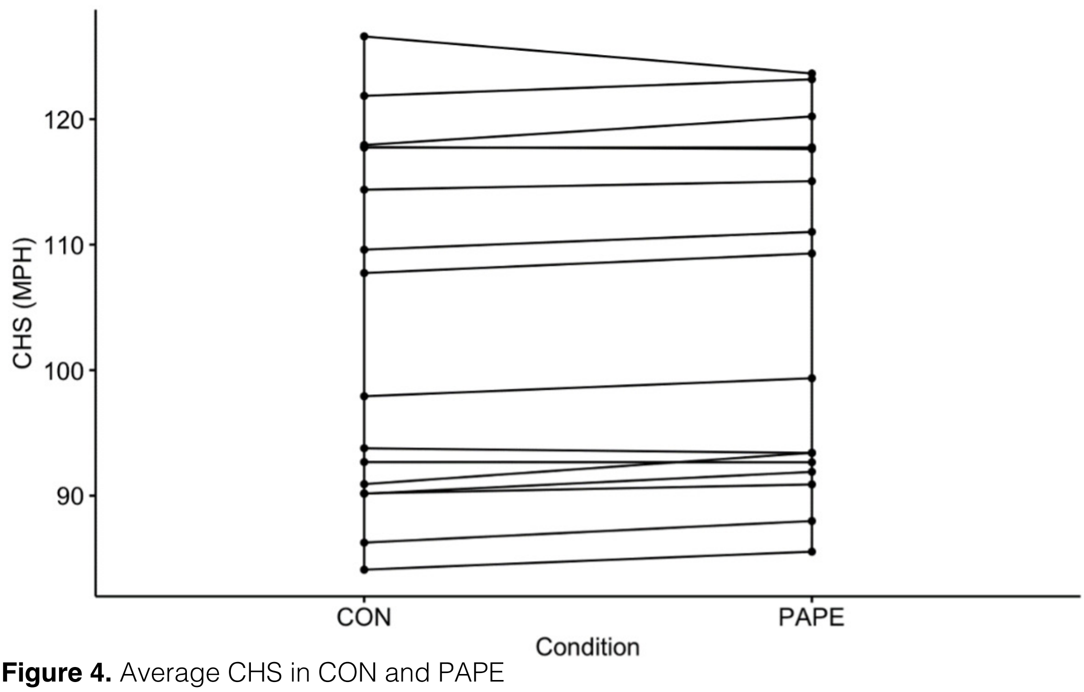

Figure 4. Average CHS in CON and PAPE

RESULTS

A paired two-sample t-test revealed a significant mean difference of +0.83 mph with a medium effect size (p = 0.02, df = 15, t = 2.50, d = 0.63), indicating CHS was increased with the PAPE strategy. Of the 16 participants, 12 increased their average CHS with the PAPE strategy. Figure 4. shows average CHS for each participant in CON and PAPE.

Paired two-sided t-tests were also conducted on participant demographics. Female participants had a significant CHS mean difference of 1.15 mph (p = .01, df = 7, t = 3.35), however, male participants did not experience a significant difference in mean CHS (p = .39, df = 7, t = .91). Previous PAPE research has suggested stronger individuals elicit more of a PAPE response (9). Further analysis was conducted to examine any trends between strength and the effects of the PAPE strategy (22,23). In this study, the individual with the largest 1RM value and CHS had a decline in CHS with the PAPE intervention. For further analysis, subjects were divided between their strength based upon 1 standard deviation of the pooled average 1RM. ANOVA showed no significant interaction between strength and the magnitude of the PAPE effect (F = 0.90, p = 0.43, df = 2).

DISCUSSION

The current study investigated the effect of a PAPE hex-bar deadlift strategy on CHS for collegiate golfers. The results of this investigation support using hex-bar deadlifts as a PAPE strategy result in acute increases in maximal CHS in collegiate golfers. Although increases in CHS were minimal, the results of this investigation indicate that using the RAMP protocol with the hex-bar as the 'potentiation' effect was significant in increasing golfers CHS. Post-activation performance enhancement effects can be attributed to multiple factors including intramuscular fluid accumulation, neural mechanisms, increased muscle sensitivity to calcium, and phosphorylation of myosin regulatory light chains (3,17). Although the present study did not measure post-activation potentiation at the level of the muscle fiber or motor unit, the physiological effects of PAPE interventions are thought to occur in type II fibers (5). Theoretically, type II muscle fibers contract faster and with greater force as a result of the maximal effort muscle contraction immediately preceding it (16,17). In the present study, the hex-bar deadlift protocol was intended to elicit maximal effort muscle contraction.

During the present study, participants were strength training 3 days a week with the golf team throughout the protocol. Since the subjects were selected from a convenience sample of one team, each subject is on the same practice and workout schedule. One group had a morning resistance training session, possibly affecting their 1-RM. To account for this, we randomized and counterbalanced the groups. This allowed the protocol to vary between subjects where personal schedules related to their physical activity were dispersed throughout sessions 1, 2, and 3. Therefore, subjects who participated in the study at the same time did not result in skewed data due to physiological muscle impairments from practice and workouts.

The results of this study expand upon previous golf specific PAPE research. Bliss et al., (6) utilized various PAPE protocols to examine the effects on CHS in 13 skilled male collegiate golfers (handicap 1.0 + 2.1). The researchers compared three separate warmup strategies- without a PAPE strategy (CON), body weight plyometrics (BWP), and swing speed sticks (SSP) as a PAPE strategy. They reported both warm-ups with PAPE strategies acutely increased CHS (6). This research is similar to the present study in that the PAPE strategies were also included in a warm-up before swinging the club, and a significant increase was found in both strategies when compared to the CON. Notably, participants rested for 1 minute before hitting 10 drives as fast as possible in the Bliss et al., (6) study. In the present study the participants rested for 15 minutes after the PAPE intervention before hitting 5 drives at max effort. Effects of exercise selection, post-activation recovery interval, swing repetition volume, rest interval duration between swing trials, or some combination of these features may have contributed to the increase in CHS in the present study being slightly less (0.83 mph) than reported by Bliss et al., (6) study (1.5 mph).

The golf study by Read et al., (21) used a countermovement jump (CMJ) as a PAPE strategy (n =16 male golfers, aged 20.1 + 3 .2 years, handicap 5.8 + 2.2). Similar to the study from Bliss et al., (6) they also used a rest period of 1 minute before swinging the driver. However, they only hit 3 drivers as fast as possible with 1 minute of rest in between each swing and reported a significant increase in CHS (+2.25mph) (21).

Additional research on PAPE has been conducted on other power-based sports. A study by Karampatsos et al., (12) examined the effects of a CMJ PAPE protocol on throwers (javelin, discus, hammer) in track and field. They found the CMJ PAPE protocol increased performance in Track and Field Athletes 1 minute before a throwing attempt (12). Furthermore, a study by Gilmore et al., (7) investigated using maximal isometric contractions to gain a PAPE effect on bat velocity in softball players. They found their PAPE protocol elicited max horizontal bat speed after a 6-minute rest period (7).

This study has several limitations including that the deadlift is a sagittal plane, closed chain movement making it nonspecific to the golf swing. The deadlift movement is an effective PAPE strategy using lower body muscles that increase power production vertically in the sagittal plane. However, a transverse plane rotational movement specified to the golf swing may elicit a greater PAPE effect for golfers. Another limitation of this study is the PAPE effect may be dependent on the individual and their experience with strength training, sex, and age. This means the results may vary between players even when the protocol was the same for everyone. Improvements in CHS were significant, and the increases were found particularly in females. Some athletes were less experienced in strength training than others, which could have influenced how the PAPE strategy influenced their effort level of a 1-RM. Therefore, influencing the results of the PAPE protocol on swing speed. Another factor that could have affected CHS performance is the time between the PAPE strategy and the CHS analysis. We had the participants wait a full 15 minutes before performing the swing speed analysis because research shows that the effects of PAPE take at least 6-10 minutes to occur and can last over 15 minutes, requiring a waiting period between the PAPE strategy and explosive activity (2,5). The 15-minute wait may present logistical challenges for golfers who wish to apply the findings of this study, as competition schedules may not afford the ability to wait 15 minutes to hit a driver during a round. However, in practice or training scenarios, the hex-bar deadlift PAPE protocol may be appropriate to elicit increased CHS, which may serve as a training stimulus to create chronic adaptation to higher CHS.

CONCLUSION

This investigation provides important insight relevant to golf strength and conditioning practices and golf performance. The finding of increased CHS following the PAPE protocol suggests the utility of heavy (i.e., progressing up to 85% of 1-RM) hex-bar deadlifts at low repetition as pre-shot routine to improve golf driving performance. Although this study only looked at using hex-bar deadlifts as a PAPE strategy to increase CHS, future research in this area could examine a more golf swing-specific movement as a PAPE strategy rather than the deadlift. This could be beneficial for golf performance by keeping CHS high throughout a round of golf if a strategy exists that increases CHS while preventing fatigue. While future research in this area is needed, the present findings provide preliminary support for the application of heavy resistance training as an acute PAPE strategy in golfers.

FUTURE RECOMMENDATIONS

Based on the findings of the present study, recommendations for future research can be made to further investigate the use of PAPE strategies for enhancing CHS in golfers. Additional research needs to be done on elite amateur female golfers to examine the physiological response to PAPE. Additionally, future studies should explore PAPE strategies with more sport-specific movements that emphasize rotational power and mimic the dynamic motion of a golf swing. Future research must also compare different recovery periods to inform which time interval has the greatest PAPE effect. Finally, long-term training studies are needed to investigate chronic benefits of regularly incorporating PAPE protocols in a golfers training regimen on CHS and overall performance.

CONFLICTS OF INTEREST

There are no conflicting relationships or activities.

FUNDING

This study received no specific funding in order to be completed.

ETHICAL APPROVAL

Ethics for this study were approved in line with University's ethics procedure. All procedures were approved by the Institutional Review Board approval # 2023ER045.

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