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Heavy Barbell Hip Thrusts Do Not Effect Sprint Performance: An 8-Week Randomized–Controlled Study

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1 **ABSTRACT**

2 The purpose of this study was to examine the effects of an 8-week barbell hip thrust strength
3 training program on sprint performance. Twenty-one collegiate athletes (15 males and 6 females)
4 were randomly assigned to either an intervention (n = 11, age 27.36 ± 3.17 years, height $169.55 \pm$
5 10.38 cm, weight 72.7 ± 18 kg) or control group (n = 10, age 27.2 ± 3.36 years, height 176.2 ± 7.94
6 cm, weight 76.39 ± 11.47 kg). 1RM hip thrust, 40m sprint time, and individual 10m split timings: 0-
7 10, 10-20, 20-30, 30-40m, were the measured variables; these recorded at both the baseline and
8 post testing time points. Following the 8-week hip thrust strength training intervention significantly
9 greater 1RM hip thrust scores for the training group were observed ($p < 0.001$, $d = 0.77$ [mean
10 difference 44.09 kg]), however this failed to translate into changes in sprint time for any of the
11 measured distances (all sprint performance measures: $p > 0.05$, $r = 0.05 - 0.37$). No significant
12 differences were seen for the control group for 1RM hip thrust ($p = 0.106$, $d = 0.24$ [mean
13 difference 9.4 kg]) or sprint time (all sprint performance measures: $p > 0.05$, $r = 0.13 - 0.47$). These
14 findings suggest that increasing maximum hip thrust strength through use of the barbell hip thrust
15 does not appear to transfer into improvements in sprint performance in collegiate level athletes.

16

17 **Key Words:** Strength Training, Sprint, Hip Thrust, Posterior Chain

18

1 INTRODUCTION

2 Sprint performance is considered a major determinant of high-level sporting performance, and has
3 additionally been shown to dictate starting position in team sports such as soccer (20) and rugby
4 (17). Considerable research to date has found strong relationships between lower body strength
5 and sprint performance (see review by Seitz et al. [32]). Within the early phases of acceleration, the
6 ability to orientate the resultant ground reaction force (GRF) application to that of a horizontal
7 nature has been strongly correlated to 100m sprint performance (24,25,26,30). Additional research
8 illustrates horizontal forces exceeding those of a vertical nature throughout the ground contact
9 phase of acceleration (546N vs. 431N; Mero, [22], as cited in Cronin & Hansen, [14]), highlighting
10 the importance of horizontal GRF within the early phases of sprint running.

11
12 The importance of the hip extensors, more specifically the gluteus maximus, plays a central role in
13 the stabilization of the hips and spine, while assisting in force production throughout hip extension
14 (15,24,25,26). One exercise which has gained popularity for its proposed effectiveness in maximally
15 activating the gluteus musculature is the barbell hip thrust (8,10). As detailed by Contreras et al.
16 (8,9), this exercise demands high levels of gluteal muscle activation, with literature reporting larger
17 electromyography (EMG) amplitudes in the gluteus maximus throughout the barbell hip thrust in
18 comparison to the back squat, hex bar deadlift, and barbell deadlift (1,9).

19
20 To the authors' knowledge, a limited sample of literature to date has investigated the effects of the
21 barbell hip thrust exercise on athletic performance measures. Mendiguchia et al. (21) conducted a
22 7-week neuromuscular training intervention consisting of two training sessions per week. Whilst
23 improvements in 5m sprint time were noted, due to the nature of the training intervention
24 encompassing aspects of eccentric exercises, plyometric exercises, and acceleration exercises, no
25 conclusive evidence as to the sole implications of the hip thrust on performance measures can be
26 attributed. Similarly, research by Rivière et al. (31), Meylan et al. (23), Brown et al. (5), and Cholewa
27 et al. (6) completed training interventions, inclusive of the barbell hip thrust; however, due to the
28 nature of the interventions incorporating a variety of additional training exercises which have been
29 shown to enhance sprint performance, no definitive conclusions can be drawn as to its efficacy as a
30 training tool. On the contrary, research by Zweifel et al. (36) conducted a pilot study comparing the
31 efficacy of the barbell hip thrust in comparison to the squat and deadlift in experienced lifters.
32 Most notable from their results was of how the barbell hip thrust (when compared to their control

1 group) identified large effect-sizes ($r \geq 0.5$) for broad jump, 40-yard sprint, and 3RM hip thrust
2 strength following a 6-week training intervention, highlighting a potential link between the barbell
3 hip thrust and increases in sprint performance. Similarly, Contreras et al. (10) also identified
4 potential benefits of the hip thrust when compared to the front squat. Notably, results identified
5 increases in sprint performance (10m and 20m), isometric mid-thigh pull strength, and hip thrust
6 3RM strength following a 6-week training intervention, with their results highlighting a link with the
7 concept of force application specificity (i.e. anteroposterior force application) when programming
8 for increases in sprint performance. Whilst Contreras et al. (10) did identify improvements
9 following the hip thrust, it should be noted that participants were youth athletes (aged 14 - 17),
10 and while they all had one year's experience squatting, no prior experience with the hip thrust was
11 noted. Therefore, caution should be applied when interpreting these results, as it is plausible that
12 any reported changes may be partially attributed to a learning effect associated with a new
13 exercise.

14
15 Seitz et al. (32) identified the back-squat exercise as lending itself to the greatest mean
16 improvements in sprint time ($3.33 \pm 2.33\%$) in comparison to exercises of a more ballistic nature
17 (e.g. loaded jump squat/countermovement jump); however, possible drawbacks have been noted.
18 For example, a study by Contreras et al. (9) compared surface EMG activity of the gluteus maximus
19 (upper and lower), biceps femoris, and vastus lateralis within both the back squat (~10 repetition
20 maximum [RM]) and barbell hip thrust (~10RM). Interestingly, the barbell hip thrust accrued
21 significantly greater EMG amplitudes for all the hip extensor muscles throughout the ~10RM set
22 (upper gluteus maximus, lower gluteus maximus, biceps femoris), with only the vastus lateralis
23 producing higher amplitudes within the back squat. Moreover, the back squat is primarily a sagittal
24 plane movement, and thus lacks specificity of anteroposterior force application noted within
25 sprinting (35). As such, it appears prudent to postulate how a hip dominant exercise such as the
26 barbell hip thrust, trained longitudinally, may lend itself to faster sprint times by maximally
27 activating the gluteus musculature to a larger extent than the back squat (1,9), whilst challenging
28 force application of an anteroposterior nature (35). Thus, further research into the training
29 implications of the barbell hip thrust on sprint performance is warranted.

30

1 Therefore, the aim of this study is to examine the effects of an 8-week barbell hip thrust strength
2 training program on sprint performance. The authors hypothesize that: 1) the barbell hip thrust will
3 lead to an increase in maximum hip thrust strength, 2) the barbell hip thrust will lead to increased
4 sprint acceleration performance over 10m, due to the demands of horizontal GRF, and 3) the
5 barbell hip thrust will lead to improvements in overall 40m sprint time.

6

7 **METHODS**

8 *Experimental Approach to the Problem*

9 A case-control study design was used to investigate the effects of an 8-week barbell hip thrust
10 strength training intervention on sprint performance over a 40m distance and 1RM hip thrust
11 strength. Performance variables were measured both at baseline (week 1), and following either an
12 8-week barbell hip thrust strength training intervention comprising of 16 training sessions, or no
13 hip thrust training, group dependent (week 10).

14

15 *Subjects*

16 A total of 21 collegiate athletes, comprising of 15 males and 6 females, volunteered to participate
17 in this study. Athletes were randomized into either an intervention ($n = 11$, age: 27.36 ± 3.17 years,
18 height: 169.55 ± 10.38 cm, weight: 72.7 ± 18 kg) or control group ($n = 10$, age: 27.2 ± 3.36 years,
19 height: 176.2 ± 7.94 cm, weight: 76.39 ± 11.47 kg). Statistical analysis (t -test) was run to confirm
20 that the groups were evenly distributed and that no significant differences were observed between
21 any of the baseline variables ($p > 0.05$ for all measures). Inclusion criteria stipulated that a one-year
22 minimum resistance training experience was required, inclusive of the barbell hip thrust, and
23 participants had to be free from injury at the commencement of the testing period. Ethical
24 approval was granted by the London Sport Institute Ethics Committee, Middlesex University.

25

26 *Procedures*

27 The present study was completed over a 10-week period. All performance testing and training
28 sessions were conducted within a performance laboratory, and participants were asked to refrain
29 from participating in any strenuous exercise on the days leading up to testing sessions. Throughout
30 week one all participants, upon arrival to the performance laboratory, completed informed consent
31 and health screening questionnaires. Participants were familiarized to the experimental conditions,

1 whereby the barbell hip thrust exercise (3 x 10 repetitions at self-selected load) and maximal
2 sprints (5 x 40m) were conducted. A minimum of 48 hours following this, baseline data for each of
3 the dependent variables was collected (40m sprint and 1RM hip thrust). Participants were then
4 randomly allocated into either the hip thrust training group or the control group. Weeks 2-9 saw
5 the completion of the training intervention, whereby participants either completed the hip thrust
6 exercise as outlined below (see “Hip Thrust Strength Training Intervention”) or acted as a control
7 group, whereby no strength training throughout the time period was conducted. Throughout the 8-
8 week intervention period, all participants were instructed to continue with their ordinary activity
9 levels, irrespective of group allocation. Week 10 comprised of post testing data collection, whereby
10 values were recorded for the dependent variables measured (40m sprint and 1RM hip thrust).

11

12 *40m Sprint Testing*

13 40m sprint testing required participants to perform three 40m maximal sprints on an outdoor third
14 generation (3G) playing surface. Sprints were separated by a 3-minute passive rest period. Infrared
15 timing gates (*Brower, Wireless TC Timing System, Draper, UT, USA*) were used to record both split
16 times: 0-10, 10-20, 20-30, 30-40m, and overall 40m sprint time. These intervals have previously
17 been considered appropriate to assess the three phases of a sprint: acceleration, attainment of
18 maximal velocity and maintenance of maximal velocity (15). All participants started in a staggered
19 stance with their preferred foot leading and were instructed to perform all sprints with maximal
20 intent, with this process repeated throughout for consistency. Standard training shoes were
21 permitted; however, to remain consistent participants were required to wear the same footwear
22 for both testing sessions (pre and post intervention time points).

23

24 *1RM Hip Thrust Testing*

25 1RM barbell hip thrust load was measured following a standardised protocol, with all participants
26 permitted 3–6 attempts undergoing 2.5% increments until 1RM was achieved (2). All hip thrusting
27 was conducted in accordance with the protocol guidelines as proposed by Contreras et al. (8).
28 Before the start of the warm-up, end range was assessed using a goniometer (90° angle at the knee
29 and neutral alignment of hips; see guidelines by Contreras et al. [8]), whereby participants
30 completed an unweighted hip thrust. An elastic band was subsequently placed at the appropriate
31 height so that the participant’s hips achieved neutral throughout each repetition. This was

1 additionally reinforced through verbal commands. Maximal intent throughout the concentric phase
2 of the lift was encouraged. Participants were required to hold the fully extended position for a 1-
3 second count, before a controlled eccentric phase to return the barbell to the ground was
4 permitted. Participants rested for a minimum of five minutes between trials until 1RM maximal
5 load was achieved.

6 7 *Hip Thrust Strength Training Intervention*

8 The hip thrust training intervention was completed between weeks 2-9 (8-week period) and was
9 solely performed by the training group. Participants performed the hip thrust exercise twice per
10 week following a loading strategy of 5 sets of 5 repetitions, with load equated at 85% of their
11 baseline 1RM (29). A 3-minute rest period between sets was permitted. All training sessions were
12 conducted on the same days within the week for each individual, and all sessions were divided by
13 72-hours. In line with a 1RM protocol, load was progressively increased by 2.5% once participants
14 were able to complete two more repetitions than the repetition goal in the final set during two
15 consecutive sessions. As proposed by Contreras et al. (10), to limit interference of additional
16 strength exercises on potential training adaptations (16), the hip thrust was the sole training
17 exercise permitted over the training period. In order for data to be accepted, 100% training
18 adherence was required. Throughout all training sessions, athletes were under supervision by a
19 strength and conditioning coach.

20 21 *Statistical Analyses*

22 Descriptive statistics were calculated and reported as mean \pm standard deviation (SD). To assess for
23 normality, a Shapiro-Wilk test was used; where $p < 0.05$, non-parametric data analysis was
24 computed. Where $p > 0.05$, parametric data analysis was conducted. Absolute reliability within
25 sprint based tests was computed through the coefficient of variation (CV). Relative reliability within
26 sprint based tests was computed through the intraclass correlation coefficient (ICC), detecting for
27 absolute agreement in both score and rank. Due to only a single score attained at each time point
28 for 1RM hip thrust, reliability was determined solely through consistency in rank order as opposed
29 to absolute agreement in scores also, with this analogously computed using the ICC. For normally
30 distributed data, a (2 x 2) repeated measures ANOVA (condition [intervention vs control] and time
31 [pre vs post]) was computed, with Bonferroni correction post hoc analysis run to determine, where

1 necessary, which measures significantly differed. For parametric data analysis, effect size was
2 reported using Cohen's *d*, with 0.2, 0.5, and 0.8 indicative of a small, moderate, and large effect
3 respectively (7). To assess for differences within non-normally distributed data, a Wilcoxon signed-
4 rank test was used. Effect size was subsequently reported using Pearson's *r*, with 0.1, 0.3, and 0.5
5 indicative of a small, moderate, and large effect respectively (7). Statistical significance was
6 accepted at 95% ($p < 0.05$). Mean percentage change (Δ) from pre to post time points was
7 reported, whereby a positive percentage change is indicative of an increase in sprint time and thus
8 reduced sprint performance, and a negative percentage change implying a decrease in sprint time
9 and thus a faster sprint. All statistical analysis was performed using SPSS software (*Version 20, IBM,*
10 *Armonk, NY, USA*).

11

12 **RESULTS**

13 All 21 athletes who volunteered to partake in this study adhered to the demands of the training
14 intervention (hip thrust vs. no hip thrust); thus, providing complete data sets (pre vs. post time
15 points) for both the hip thrust training intervention group ($n = 11$) and the control group ($n = 10$)
16 (see Table 1).

17

18 *** *INSERT TABLE 1 ABOUT HERE* ***

19

20 All variables of sprint time were identified as non-normally distributed; 0-10 ($p < 0.001$), 10-20 ($p <$
21 0.001), 20-30 ($p < 0.001$), 30-40 ($p < 0.001$), and 40m ($p < 0.001$); thus, non-parametric data
22 analysis was computed, with effect size reported as Pearson's *r*. Hip Thrust 1RM was identified as
23 normally distributed ($p = 0.592$); thus, parametric data analysis was computed, with effect sizes
24 reported as Cohen's *d*. All measures of sprint time attained at the baseline time point reported high
25 levels of both absolute reliability ($CV = 1-3.3\%$), and test-retest reliability (see Table 2), with ICC
26 values reporting almost perfect agreement ($ICC = 0.911-0.996$). Hip thrust 1RM reported high
27 levels of rank order consistency for test-retest reliability for both the intervention group ($ICC =$
28 0.93 , 95% CI: 0.762-0.981) and control group ($ICC = 0.955$, 95% CI: 0.831-0.989).

29

30 *** *INSERT TABLE 2 ABOUT HERE* ***

31

1 *Control Group*

2 Over the 8-week intervention period, the control group saw no meaningful improvements in any of
3 the split timings for sprint performance; 0-10m ($\Delta = 0.19\%$, $p = 0.68$, $r = 0.13$), 10-20m ($\Delta = 1.51\%$, p
4 $= 0.13$, $r = 0.47$), 20-30m ($\Delta = 2.15\%$, $p = 0.17$, $r = 0.44$), 30-40m ($\Delta = -0.76\%$, $p = 0.37$, $r = 0.28$).
5 Additionally, no significant improvements in overall 40m sprint performance were noted ($\Delta =$
6 0.89% , $p = 0.38$, $r = 0.27$).

7
8 *Hip Thrust Intervention Group*

9 Similar to the control group, no meaningful improvements were noted for any of the split timings
10 for sprint performance; 0-10m ($\Delta = 3.92\%$, $p = 0.44$, $r = 0.23$), 10-20m ($\Delta = -0.76\%$, $p = 0.22$, $r =$
11 0.37), 20-30m ($\Delta = -0.24\%$, $p = 0.76$, $r = 0.09$), 30-40m ($\Delta = 0.51\%$, $p = 0.86$, $r = 0.05$). Furthermore,
12 no significant improvements in overall 40m sprint performance were identified ($\Delta = 0.88\%$, $p =$
13 0.42 , $r = 0.24$).

14
15 *1RM Hip Thrust*

16 ANOVA identified a significant interaction effect of condition (intervention vs. control) and time
17 (pre vs. post) [$F_{(1,19)} = 20.497$, $p < 0.001$, $d = 0.519$]. Post hoc analysis identified significantly greater
18 1RM hip thrust scores for the intervention group at the post testing time point (see Figure 1) when
19 compared to baseline ($p < 0.001$, $d = 0.77$ [mean difference 44.09 kg]). No significance was seen for
20 the control group (see Figure 2), when compared to its respective baseline measure ($p = 0.106$, $d =$
21 0.24 [mean difference 9.4 kg]).

22
23 *** INSERT FIGURES 1 AND 2 ABOUT HERE ***

24
25 **DISCUSSION**

26 The present study set out to determine the sole use of the barbell hip thrust over an 8-week
27 strength training period, in an attempt to augment sprint performance. It was hypothesized that
28 the training intervention would lend itself to both increases in maximum hip thrust strength, but
29 also transfer to increases in sprint performance. While previous studies have widely found
30 noteworthy improvements in sprint velocities with lower body strength developments (see review

1 by Seitz et al. [32]), the findings of the present study appear to oppose such evidence. Within the
2 present study, a moderate training effect for the barbell hip thrust on 1RM hip thrust strength was
3 noted ($d = 0.77$), however this failed to translate into increases in sprint performance, with no
4 meaningful improvements in any of the split timings ($r = 0.05 - 0.37$) or overall 40m sprint
5 performance ($r = 0.24$) noted following the strength training intervention. These findings suggest
6 that heavy barbell hip thrusts do not facilitate sprint performance following an 8-week strength
7 training period in a sample of collegiate athletes.

8
9 A moderate within-group training effect was noted for 1RM hip thrust strength following the 8-
10 week training intervention, with group mean values illustrating a pre to post change of 44.09kg.
11 This data falls in line with previous research, for example by Crewther et al. (12), who suggests
12 heavy strength training loads (85-100% 1RM) to induce optimal increases in strength, this achieved
13 through neural mechanisms, for example through enhanced neural coordination. To load the
14 athletes within the present study, 85% of 1RM was used, with load increased by 2.5% once
15 participants could complete two more repetitions than the repetition goal in the final set during
16 two consecutive sessions (29). Research by Contreras et al. (10) undertook a different approach,
17 whereby participants were loaded over a 6-week period, with loads starting at 12RM (week 1) and
18 ending at 6RM (week 6). Interestingly, Contreras et al. (10) identified moderate effects between
19 groups at the post testing time point, with results favoring the hip thrust over the front squat for
20 both 10m ($d = 0.32$) and 20m ($d = 0.39$) sprint times. Similarly, a recent pilot study by Zweifel et al.
21 (36) acknowledged improvements in sprint performance with strong effect sizes noted following a
22 6-week training intervention period, with loads ranging from 30% to 100% of each athletes 1RM.
23 This raises the question therefore as to optimal loading strategies to enhance sprint performance
24 within the hip thrust exercise, questioning as to whether reduced intensity loading strategies (6-
25 12RM) may in fact be more favorable for the hip thrust exercise. Previous research has noted peak
26 power to occur at approximately 56% 1RM within the back squat exercise (11). Whilst it can be
27 argued of the vast kinematic dissimilarities of the back squat to the hip thrust, the principle of sub-
28 maximal loads to ascertain peak power must be noted. In this instance, Contreras et al. (10) used
29 60% 3RM within week 1, this most likely closer to each individuals peak power threshold, and thus
30 velocity transference to sprint running may have been greater. With this in mind therefore, further

1 research in this area is warranted to greater understand loading strategies and their transference
2 to sprint performance within the barbell hip thrust exercise.

3
4 Further mechanisms thought to have affected the findings of the present study are the variability
5 of sprint mechanics seen within untrained athletes regarding level of prior technical sprint training.
6 An individual's ability to sprint is heavily determined by multiple facets such as stiffness upon
7 ground contact, stretch shortening cycle capabilities, ground contact time, stride length, stride
8 frequency, recruitment of additional musculature (3,15,19,28). The athletes in the present study
9 were adult collegiate level athletes, this in comparison to adolescent athletes used by Contreras et
10 al. (10) who were enrolled within either the New Zealand rugby or rowing athlete development
11 programs. This variability in sprint performance may be part explained from a study by Bradshaw et
12 al. (4). The authors investigated the movement variability within sprint trained athletes (aged 17 –
13 23 years, 100m personal best: 10.87 ± 0.36 s), assessing biological movement variability within the
14 start and early acceleration phases of a sprint. Most interesting from their findings was of how
15 individual variability within start position angular kinematic parameters, reported through the
16 coefficient of variation (CV), was reported to be as high as 24.54%. Within the present study, no
17 measure of the process used to complete the sprint was attained (i.e. kinematic variables), solely
18 the outcome of the sprint (i.e. sprint time) was measured. However, to standardise the start
19 position within the present study (due to its implications on kinematic parameters within early
20 acceleration [4]), participants were required to start each trial in a staggered stance with their
21 preferred foot leading, and this was consistent throughout the testing process to confine such
22 issues. Nonetheless, considerations for alterations in kinematic parameters should be noted,
23 highlighting considerations for future research.

24
25 A potential limitation to be noted within the present study is of how both males and females were
26 recruited. Although gender differences in sprint performance have received limited attention (13),
27 males are generally seen to have a higher absolute and relative power output than females (18),
28 and typically longer lower limbs (33). This information may suggest shorter stride lengths within
29 females compared to males, which as such may contribute to slower sprint speeds. The present
30 study corroborates with such results, with males identifying faster sprint times than females at the
31 baseline time point (males: 5.78 ± 0.68 s vs. females: 6.62 ± 1.5 s). Further to this, whilst similar

1 changes were seen across the intervention following the barbell hip thrust for both males ($5.78 \pm$
2 $0.68s$ pre to $5.83 \pm 0.54s$ post) and females ($6.62 \pm 1.5s$ pre to $6.62 \pm 1.27s$ post), the disparity in
3 genders by virtue of the deviance in scores may in turn increase the standard deviation of the data,
4 which as such may mask any statistically true change from pre to post training intervention. To
5 negate such issues however within data analysis, all data for sprint time was reported as individual
6 percentage change from pre to post testing time points. Future research however could look to
7 explore this concept further, given the implications of posterior chain development within female
8 athletes on both injury and performance (27). Additionally, a lack of more complex metrics (due to
9 the limited access to expensive equipment), for example a force plate to measure kinetic variables
10 such as peak force/rate of force development (RFD), or 3D motion capture to derive kinematic
11 variables, hinders the ability to generalise the findings of the present study outside the scope of
12 outcome measures (i.e. 40m sprint time and hip thrust 1RM), as opposed to the process carried out
13 to achieve this (i.e. kinematic parameters, force-time characteristics).

14

15 **PRACTICAL APPLICATIONS**

16 The present study set out to examine the effects of a heavy barbell hip thrust on sprint
17 performance over an 8-week training period in a sample of collegiate athletes. While previous
18 studies have identified increases in speed and acceleration performance following use of the
19 barbell hip thrust (10,36), the findings of the present study do not appear to support such
20 evidence. It appears therefore that the usefulness of heavy barbell hip thrusts to enhance sprint
21 performance remains questionable. These findings, combined with those of Contreras et al. (10),
22 may suggest how 6–12RM loads may be more favorable in attaining increases in sprint
23 performance, perhaps due to a greater velocity transference to sprinting. As such, further research
24 is warranted, with specific importance on loading intensities and their transference to sprint
25 performance. Furthermore, comparison between the barbell hip thrust and the back squat
26 following a training intervention is necessary, due to greater absolute loads attainable in the back
27 squat compared to the front squat (as seen by Yavuz et al. [34]), thus theoretically leading to a
28 superior training adaptation from a force application perspective, but also due to the high
29 correlations with back squat strength and sprint performance (32).

30

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4

1 **Table 1.** Pre and post intervention performance data with absolute and percentage differences.

2

Test	Intervention				Control			
	Pre	Post	Absolute Difference	Percentage Difference	Pre	Post	Absolute Difference	Percentage Difference
0-10m (s)	1.80 ± 0.26	1.86 ± 0.23	0.06 ± 0.14	3.92%	1.71 ± 0.27	1.69 ± 0.15	-0.01 ± 0.19	0.19%
10-20m (s)	1.50 ± 0.26	1.48 ± 0.24	-0.01 ± 0.04	-0.76%	1.36 ± 0.13	1.38 ± 0.11	0.02 ± 0.04	1.51%
20-30m (s)	1.42 ± 0.30	1.41 ± 0.25	-0.01 ± 0.07	-0.24%	1.29 ± 0.15	1.32 ± 0.15	0.03 ± 0.05	2.15%
30-40m (s)	1.41 ± 0.33	1.41 ± 0.28	0.00 ± 0.08	0.51%	1.32 ± 0.19	1.30 ± 0.18	-0.01 ± 0.04	-0.76%
Total 40m (s)	6.16 ± 1.15	6.19 ± 0.97	0.03 ± 0.22	0.88%	5.69 ± 0.73	5.73 ± 0.56	0.03 ± 0.21	0.89%
1RM hip thrust (kg)	161.8 ± 50.41	205.9 ± 63.27 **	44.09 ± 21.43	28.52%	164.6 ± 36.71	174 ± 41.88	9.4 ± 11.8	5.43%

Notes: Values represented as mean ± SD; Pre = before training intervention; Post = after training intervention; 0-10m = 0-10m split sprint time; 10-20m= 10-20m split sprint time; 20-30m = 20-30m split sprint time; 30-40m = 30-40m split sprint time; 40m = total 40m sprint time; 1RM = 1 Repetition Maximum.

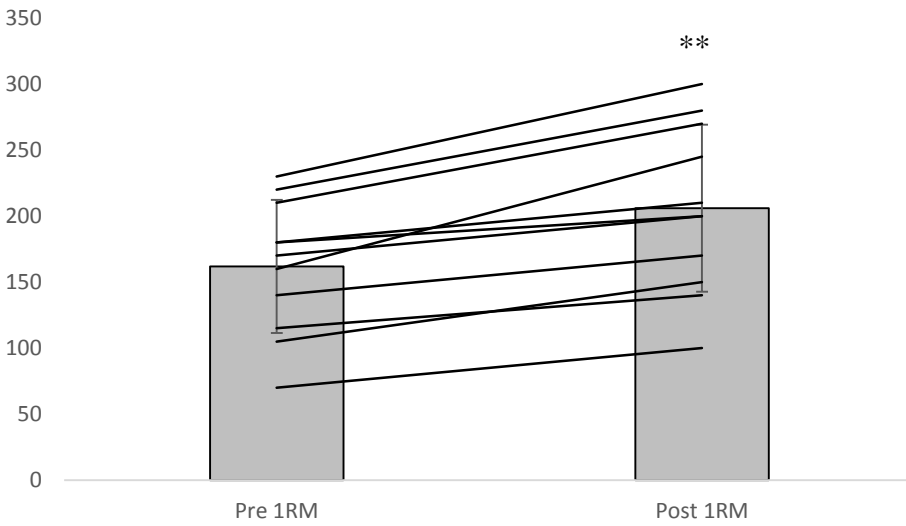
** Denotes significantly different between time points (pre – post), $p \leq 0.05$

3

1 **Table 2.** Reliability data for all sprint conditions.

2
3

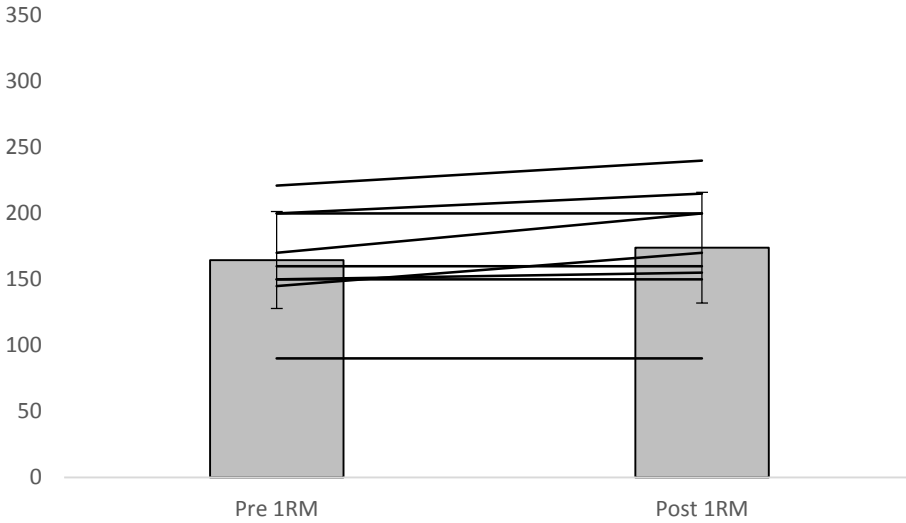
Test	Hip Thrust Intervention Group					Control Group			
	CV (%)	Intraclass	95% Confidence Interval			CV (%)	Intraclass	95% Confidence Interval	
		Correlation	95% CI		Correlation		95% CI		
		Coefficient (ICC)	(lower bound)	(upper bound)	Coefficient (ICC)		(lower bound)	(upper bound)	
0-10m	2.3	.967	.913	.990	1.0	.996	.988	.999	
10-20m	1.6	.991	.975	.997	1.7	.958	.885	.989	
20-30m	1.3	.995	.985	.999	2.4	.931	.820	.981	
30-40m	1.6	.995	.986	.998	3.3	.911	.773	.975	
40m	1.1	.996	.986	.999	1.5	.977	.937	.994	



2
 3 **Figure 1.** Hip thrust strength training group baseline vs. post testing mean and individual data for
 4 1RM hip thrust (kg).

5 ** denotes significantly different from baseline value ($p < 0.05$)

6
 7



8
 9 **Figure 2.** Control group baseline vs. post testing mean and individual data for 1RM hip thrust (kg).