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The Effects of Olympic Weightlifting Derivatives on Muay Thai Roundhouse Kicking Performance

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ABSTRACT

The purpose of this study was to identify performance measures in roundhouse striking, by the implementation of Olympic Weightlifting Derivatives (OWLD) with Muay Thai fighters. Forty male subjects were recruited, with twenty male subjects placed in the experimental group (EG)and twenty male subjects in the control group (CG) and were randomly assigned to their groups. Mean 26 years 3 (± 3.2), weight and height 82.4 kg (± 12.2), and 180.7cm (± 3). Pre- and post-intervention and control group testing included roundhouse strike impact power, measured using the PowerKubeTM, a dynamometer that identifies the impact power used to produce striking potential. Countermovement jumps were recorded using a single PASCO force platform one axis PS2141. The EG subjects were prescribed an eight-week training programme that was carried out prior to their sparring with twenty minutes rest to recover. The control group were instructed to carry out traditional training that involved the same volume of sparring, cardiovascular fitness, and circuit training as the EG. Within-group post test results showed the EG and CG group demonstrated significantly different results in RHK performance ($p \leq 0.01$); however, no significant differences were observed between groups. Results in the countermovement jump were, however, highly significant ($p \leq 0.01$) in the EG (within group), but not significant in the CG ($p \geq 0.05$); again, no significant differences were observed between groups. Meaningful differences were seen in the EG with a 7.41% increase in roundhouse kicking performance and 7.54% in countermovement jump height, compared to the CG that elicited negligible differences of only 1.56% in the roundhouse kicking performance and 0.33% in countermovement jumper, demonstrating OWLD would improve the performance of the Muay Thai fighter.

Keywords: Muay Thai, Weightlifting, Training, Roundhouse, Power

INTRODUCTION

Muay Thai, translated to Thai boxing in English, originated in Thailand and has been characterized as the art of eight limbs, where athletes can strike their opponents with kicks, punches, knees, elbows, and grapple. A Muay Thai bout can be scheduled to five rounds of three minutes, but it may vary according to the competitors' experience. Muay Thai fighters, also referred to as Thai boxers, are matched by weight and experience, as they are in most combat sports. Fitness conditioning appears to be gained through a traditional combination of running, pad work and sparring, similar to boxing and most martial arts . Thai boxers can be hesitant to engage in strength training as their concerns are losing flexibility and gaining excessive weight [1-4]. However, fighters will frequently attempt to compete against opponents of lesser mass, perceiving it to gain advantage due to heavier mass, by employing weight cutting cycling methods pre-competition, which sees the fighter aggressively dehydrate using heat stress and water starvation [5]. Aggressive weight cutting cycling (>2% body weight) has been the cause of avoidable deleterious effects and even fatalities. Increasing power output that is derived through explosive training into striking potential, without gaining mass, would be beneficial to the Muay Thai fighter and may avoid strategies of weight cutting cycling pre-competition [6-7]. Research aimed at identifying the benefits of Olympic weightlifting has shown an increase in athletic performance in various sports, with an increase in the Rate of Force Development (RFD), speed strength, velocity, muscle stiffness and power [8-12]. With enhanced potentiation of motor unit recruitment and rate coding seen with Olympic weightlifting, this training modality would benefit combat sports. Bruce-Low and Smith suggest explosive and powerful exercises such as Olympic weightlifting are not deemed to be effective in producing athletic gains, compared to slow and traditional training, also suggesting that Olympic weightlifting could cause detriments in athletic performance and increase injuries, due to complexity of the technique. However, it is shown that an increase in levels of force and power are produced in Olympic weightlifting, which are transferable to other sports by improving athletic performancedemonstrated derivatives of Olympic weightlifting to be effective in the development of RFD, which consist of segments of the snatch and clean pull; such as high pulls, jump shrugs, push jerk, squats and deadlifts). The Olympic lifting derivatives lifts require less motor skill acquisition due to simplifying the movement throughout the technique [13-17]. In many instances, the derivatives of Olympic weightlifting would be a preferred method due to the lack of expertise required by the athlete to perform, where critical features of the lift are minimal, and focus on executing the triple extension [18]. The triple extension is a term commonly used to identify a movement that expresses multiple muscle groups which contract at the ankle, knee, and hip joint in a singular synergistic action to produce work [19]. Any standing athletic movement that requires the body to produce work can be assumed to use the triple extension, such as kicking in the sport of Muay Thai, where it is the primary purpose to strike an opponent to cause injury with the aim of stopping them by knockout from using explosive power by striking or by points won on effective strikes landed .The triple extension is seen in biphasic motion from flexion to the extension when kicking, with the front kick moving in a sagittal plane and the roundhouse through the transverse plane with greater angular velocity of the hip. In comparison to other martial arts, Thai boxers use more muscular force and hip angular velocity through the triple extension, to enhance roundhouse striking power than that of Taekwondo, for winning performances [20-21]. The purpose of this study is to identify any effects of Olympic weightlifting derivatives intervention on kick striking performance in Muay Thai. We hypothesise that Olympic Lifting derivative exercises increase roundhouse kicking performance by increasing impact power.

MATERIALS AND METHODS

Experimental approach to the problem

A repeated measures design was used to study and identify any increase in performance with the implementation of OLWD. The intervention was applied to experienced Thai boxers with two years of resistance training and 10 ± 2) professional fights. The developed intervention programme was employed as an addition to the Experimental Group (EG) regular training and was carried out right before their technical sparring days. The Control Group (CG) trained with to their regular training regime, that included only sparring and high intensity intermittent cardio training exercises such as skipping, running and pad work.

Subjects

The subjects (26.3 ± 3.2 years; 82.4 kg ± 12.2; 180.7 cm ± 8.3), were randomly assigned to one of two groups: experimental (EG) (n=20) or control (CG) (n=20). All subjects were experienced Thai boxers from gyms based in London with a minimum of two years competitive experience with 12 ± 2 professional bouts, a with over two years in resistance training experience (2 ± 2). All subjects reported being clear of injury for a minimum of six months. Participant's stature (Seca 213, Birmingham, UK) and body mass (Seca 761, Birmingham, UK) were measured before testing. All subjects provided written informed consent to participate, and the study was approved by the institutional ethics committee at the University of East London.

Procedures

Subjects arrived at the laboratory in a rested state, with no exertional work or physical training seventy-two hours prior to testing to ensure a rested state. BASES participation to exercise questionnaire was completed by the subjects, showing no illnesses or injuries, and cleared for testing. Pre- and post-intervention and control group testing included roundhouse strike impact power, measured using the PowerKubeTM (Birmingham, U.K), a dynamometer that accurately identifies the impact power (W) used to produce striking potential.

The impact power of punching and kicking was measured using the PowerKubeTM (Strike Research, Norfolk, UK), a commercial impact power measurement equipment designed for combat sports. The portable PowerKubeTM weighs 3 kg and measures 305 mm by 305 mm by 250 mm deep. It is constructed from a blockof open-cell foam that is sandwiched between two solid surfaces to enable controlled compression. Two accelerometers embedded in resin are coupled to specialised software to provide instant data on the impact power of punching and kicking. Previous research has demonstrated that the PowerKubeTM is a reliable instrument for determining the impact power of a strike (ICC=0.98, TEM 3.0%).

Counter Movement Jumps (CMJ) were recorded using a single PASCO force platform one axis PS2141 (Roseville, USA), observing peak height. Equipment familiarisation such as accuracy on the PowerKube was carried out with the subjects Muay Thai coach overseeing, one week prior to testing and the countermovement jumps to ensure correct technique was used.

Table 1. The eight-week OLWD programme, including exercises, volumes, and intensities for the experimental group

Exercise	Volume and intensity Sets × Reps	Restorative period between sets	Week
Jump shrugs-clean pulls-partial squats	3 × 6 RM	3 mins	1
Jump shrugs-clean pulls-partial squats	5 × 5 RM	3 mins	2
Jump shrugs-clean pulls-partial squats	5 × 4 RM	3 mins	3
Jump shrugs-clean pulls-partial squats	5 × 5 RM	3 mins	4
Snatch pulls-push jerk-high pulls	5 × 5 RM	4 mins	5
Snatch pulls-push jerk-high pulls	5 × 4 RM	4 mins	6
Snatch pulls-push jerk-high pulls	5 × 5 RM	5 mins	7
Snatch pulls-push jerk-high pulls	4 × 6 RM	5 mins	8

Both the control and the experimental groups carried out an initial baseline testing of one repetition maximum back squat, to ensure that all subjects could lift with correct technique, to decrease injury likelihood and to prescribe intensity throughout the programme, using the NSCA protocol [22]. A ten-minute warm up by each subject, using a stationary exercise bike (Technogym, U.K.) and then followed by dynamic stretches preceded both testing sessions and intervention training, to prepare the body and connective tissues, to increase performance and decrease rates of injury (Table 1). All subjects completed the 8-week intervention injury free and without dropping out. The EG subjects were prescribed an eight-week training programme that was carried out prior to their sparring with twenty minutes rest to recover, all sessions were supervised and lead by a National Strength and Conditioning Association certified strength and conditioning coach, with a level 2 in Olympic Weightlifting (British Weightlifting). The control group were instructed to carry out traditional training that involved the same volume of sparring, cardiovascular fitness and circuit training as the EG.

Statistical Analysis

All data were checked for normality using the Shapiro-Wilk test; all data were normally distributed (Table 2). Paired and independent samples t-tests were used to determine any significant differences within and between groups in CMJ and PowerKube scores following roundhouse kicks; effect sizes were also calculated using Cohen's d. Correlation coefficients were calculated to identify the strength of relationships between variables within groups; to determine any difference in the strength of relationships between groups, Z-scores and p values were used [23].

RESULT

Table 2 illustrates participant characteristics of both groups, Table 3 presents pre and post-performance measures and Table 4 Reports on the percentage differences between pre and post measures.

Table 2. Subject characteristics

Group	Age	Weight	Height	Bouts
EG n=20	25.5 years ± 4	81.1 kg ± 7.1	180.2 cm ± 3.5	12.6 ± 2.1
CG n=20	26.3 years ± 5	83.6 kg ± 3.4	180.9 cm ± 7.6	12.2 ± 3.7

Table 3. Pre and post-performance measures for RHK and CMJ. Data presented as mean (standard deviation), minimum, maximum and range of values

Group	Outcome	Mean (SD)	Confidence Interval
Experimental Control	Roundhouse pre	37288.55	L: 34542.76
		-5866.88	U: 40034.34
		37742.55	L: 35137.66
		-5565.83	U: 40347.44
Experimental	Roundhouse post (Watts)	39990	L: 37163.54
		-6039.59	U: 42816.76
Control		38.297.00	L: 35765.36
		-5410.61	U: 40829.84
Experimental	CMJ pre (cm)	34.75	L: 32.65
		-4.48	U: 36.85
Control		37.3	L: 34.84
		-5.25	U: 39.76
Experimental	CMJ post (cm)	37.3	L: 35.21
		-4.47	U: 39.39
Control		37.38	L: 35.06
		-4.37	U: 39.69
**L: lower bound; U: upper bound			

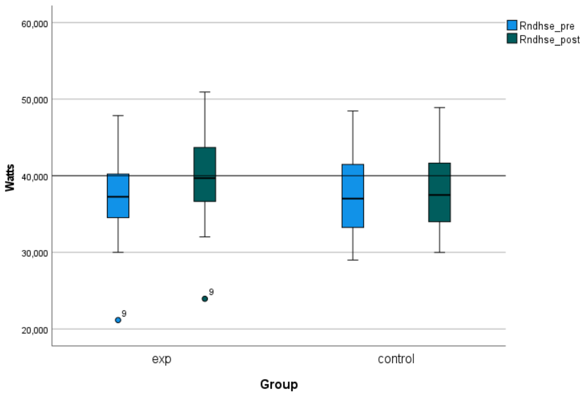

Figure 1. Roundhouse kick impact power output for experimental and control groups, pre and post intervention (Data presented as mean and standard deviation)

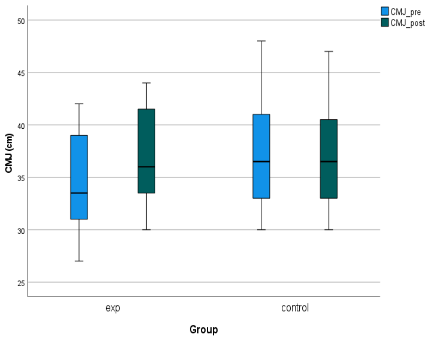

Figure 2. Countermovement results for experimental and control groups, pre and post intervention (Data presented as mean and standard deviation).

Table 4. Percentage change in RHK and CMJ for experimental and control groups. Data presented as mean and (standard deviation)

	Experimental	**Control**
RHK	7.41* (± 2.57)	1.56 (± 0.93)
CMJ	7.54* (± 4.15)	0.33 (± 2.16)
* Denotes highly significant difference ($p \leq 0.01$)		

Within groups

There were highly significant differences with a large effect size between RHK scores in the experimental group (t=-13.971 (19), $p \leq 0.01$; *d*=1.86). A similar trend was observed in CMJ (t=-9.575 (19), *p*=<0.01; *d*=1.19).

The control group also exhibited highly significantly different results in RHK but not for CMJ (t=-8.937(19), $p \leq 0.01$; *d*=278.0; t=-0.396 (19), $p \leq 0.05$; *d*=0.8 respectively) (Figure 1).

Between groups

(Table 3; Figure 2) Present that there were no significant differences between groups for any variable either pre or post intervention. However, exploration of the percentage difference did reveal highly significant differences between the groups with the experimental group exhibiting greater improvements in performance (RHK: t=9.56

(38), *p*=<0.01; *d*=1.93; CMJ: t=6.88 (38), $p \leq 0.01$; *d*=3.31); effect sizes are large.

(Table 5) Presents Pearson correlation coefficients (r) and shared variance (r2); unsurprisingly, there were highly significant relationships between CMJ and RHK both pre and post intervention and in the control group.

Using z-scores for the difference between two correlations obtained for independent samples it is possible to determine whether correlations are comparable between groups, or significantly different; in this study, the relationships between groups were not significantly different.

Table 5. Pearson correlation coefficients and shared variances between outcome measures. Data presented groupwise

EXP		RHK pre	RHK post	CMJ pre	CMJ post
RHK pre	*r*		.990**	.849**	.738**
	r^2		0.98	0.72	0.545
RHK post	*r*	.990**		.856**	.773**
	r^2	0.98		0.733	0.6
CMJ pre	*r*	.849**	.856**		.965**
	r^2	0.72	0.733		0.931
CONT.		RHK pre	RHK post	CMJ pre	CMJ post
RHK pre	*r*		.999**	.892**	.876**
	r^2		1	0.8	0.767
RHK post	*r*	.999**		.894**	.878**
	r^2	1		0.799	0.771
CMJ pre	*r*	.892**	.894**		.988**
	r^2	0.8	0.799		0.976
** denotes highly significant ($p<0.01$)					

DISCUSSION

This study was to determine if any effects were made by implementing Olympic weightlifting derivatives modalities to the athletic preparation of Thai boxers, specifically in kicking impact power performance. Forty subjects were recruited from Muay Thai gyms based in London, with twenty subjects in the control group that carried out their regular training, which did not include any resistance training, and twenty subjects that also carried out their regular training but with the supplemented weightlifting sessions throughout the week. All subjects from both the control group and the experimental group successfully completed the experiment without injury or interrupting their fight training preparation.

Within-group post test results showed the EG and CG group demonstrated significantly different results in RHK performance ($p \leq 0.01$); however, no significant differences were observed between groups. Results in the countermovement jump were, however, highly significant ($p \leq 0.01$) in the EG (within group), but not significant in the CG ($p \geq 0.05$); again, non-significant differences were observed between groups. When exploring percentage differences between groups, the EG exhibited a 7.41% increase in roundhouse kicking performance and 7.54% in countermovement jump height. In contrast, the CG elicited negligible differences of only 1.56% in the roundhouse kicking performance and 0.33% in countermovement jumper (Table 4; Figure 3) suggesting that meaningful differences were observed in the EG.

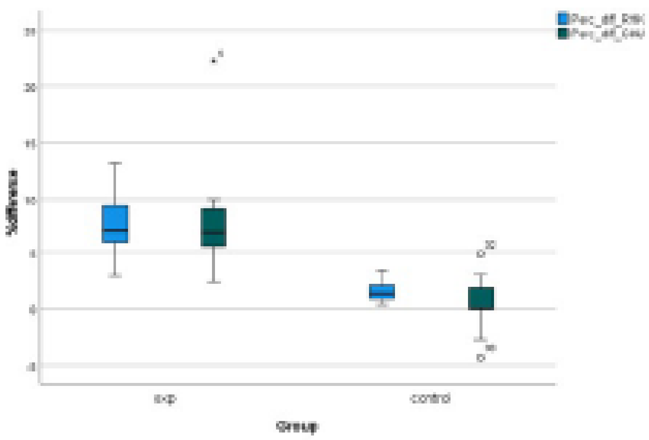

Figure 3. Percentage change in RHK and CMJ for experimental and control groups

Meaningful differences have been shown in this study to support the hypotheses that Olympic lifting derivative modalities improve kick striking in Muay Thai fighters over an eight-week period (7.41%). Although no significance between groups was seen, Sullivan and Feinn suggest that determining outcomes by significance values is whether the experiment affects people, however, it should be stated by the magnitude of how much they are affected [24]. Solla et al. also state that the p-value shows the result is possibly due to chance, but again, without the inference of change effect size, and that the value of the study could be diminished where the outcomes that would incur a better understanding could be hindered. Hubbard and Murray-Lindsay reported that instead of p-values, effect sizes and their confidence intervals would serve as more reliable values, hence the inclusion in this study [25-27].

When compared to the CG, the EG improved their striking impact power by 5.85%, which would confer a greater destructive roundhouse kick that would improve the performance of the Thai boxer. It could be argued that a 5.85% improvement of roundhouse striking over eight weeks is not sufficient to implement a higher volume of work that could deter from more sports specific training such as pad work and sparring, or rest and recovery. However, finite physiological and performance improvements in advanced and professional athletes are considered to be beneficial, even at higher costs, due to the athletes reaching their genetic ceiling of potential and differing modalities such as Olympic weightlifting are required to invoke positive performance change .

Countermovement jumps were assessed in this study to ensure that any differences in roundhouse kicks were comparative to those made in a standardised physiological measure of the force produced in the triple extension. The EG demonstrated significant change ($p \leq 0.01$) whereas the CG did not ($p \geq 0.05$), but more importantly, the meaningful differences showed a positive improvement of 7.54% and the CG of only 0.33% over eight-weeks. With small increases in a diminutive period, it could be postulated that athletic increases over a more substantial period would incur greater improvements to the CMJ and athletic performances as seen in previous studies. the triple extension enhancement would be a direct improvement of the roundhouse.

A possible limitation of the current work is that no monitoring of bar velocity on the Olympic lifting was carried out, therefore increasing the weight was done through the subject's ability to maximise their progression through verbal and visual feedback from the subjects during and post lifting. Using an encoder or accelerometer would have determined the rate of velocity and therefore improved programme prescription and ensured overreaching by selecting weight on the bar matched the target velocity. Future studies should use known valid technology such as encoders to ensure any increases in weight are monitored.

In summary, this research reports that Olympic lifting derivatives are safe and effective to use to improve kick striking performance in Muay Thai subjects, that can be built into the programme of athletes prior to training or competition.

CONCLUSION

Olympic weightlifting has been shown to develop increases in power and rate of force development which positively influences athletic performance. Full Olympic lifts are complex and technical success in the coaching of such modality can be time consuming and may cause injury if performed incorrectly. To improve the chances of gaining the potential and avoiding detriments such as time lost and injuries, the derivatives of these lifts, such as jump shrugs and clean pulls are recommended when periodising the Muay Thai fighters programming. With time constraints and fatigue factors being a larger part of the coaches' concerns, the derivatives could be placed before other training on the same day due to the physiological nature of the lifts not being taken to exhaustion and may even be placed in the warmup to evoke a post activation potentiation enhancement.

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