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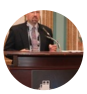
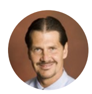


David M. Bellar
University of Louisiana at Lafayette



Lawrence W Judge
Ball State University

Efficacy of Potentiation of Performance Through Overweight Implement Throws on Male and Female Collegiate and Elite Weight Throwers

David Bellar,[1] Lawrence W. Judge,[2] Mike Turk,[3] and Mike Judge[4]

[1]Department of Kinesiology, University of Louisiana Lafayette, Lafayette, Louisiana; [2]School of Physical Education, Sport, and Exercise Science, Ball State University, Muncie, Indiana; [3]Department of Athletics, University of Illinois Urbana-Champaign, Urbana, Illinois; and [4]Throw One Deep Sports Club, Marietta, Georgia

Abstract

Bellar, D, Judge, LW, Turk, M, and Judge, M. Efficacy of potentiation of performance through overweight implement throws on male and female collegiate and elite weight throwers. *J Strength Cond Res* 26(6): 1469–1474, 2012—The purpose of this investigation was to determine the acute effects of 2 different overweight implements on weight throw performance. Seventeen collegiate and elite weight throwers were recruited to participate. A within-subject design was used to compare the difference between mean and peak distance after warm-up with a regulation weight (STAND), 1.37-kg overweight (OVRWGHT1), and 2.27-kg overweight implement (OVRWGHT2). Repeated-measures analysis of variance revealed a main effect for Treatment ($p = 0.006$) and a significant interaction effect for Treatment by Time ($p = 0.041$). The means for the OVRWGHT1 treatment (16.08 ± 2.5 m) and OVRWGHT2 (16.08 ± 2.7 m) were not different; however, the mean for STAND was significantly lower than that for the other treatments (15.58 ± 2.5, $p < 0.02$). Changes in performance between OVRWGHT treatments and STAND were found to correlate to one-repetition maximum (1RM) Power Clean (improvement for OVRWGHT 1, $r = 0.536$, $p = 0.016$; improvement for OVRWGHT2, $r = 0.548$, $p = 0.014$). The results suggest that in collegiate and elite athletes overweight implement warm-up may improve performance and that stronger athletes may be better suited to take advantage of this effect.

Key Words weight throw, PAP, warm-up

Introduction

The weight throw is an explosive event in which the competitive athlete performs between 1 and 4 rotations within a 2.135-m ring and releases a 40.6-cm long implement with a mass of either 15.87 kg for male competitors or 9.07 kg for female competitors at the collegiate level. The athletes involved in this event must generate as much velocity with the implement as possible, while maintaining balance and coordination through the sequence of turns. As is the case in most throwing events in the sport of track and field, technical or skill-related deficiencies are often related to a lack of strength (18,29). The successful coach has to incorporate sufficient training stimuli through resistance training to develop the necessary strength levels for athletes to advance technically (4). Strength not only appears to be necessary for the technical development in the weight throw and other track and field throwing events, but it is also related to the actual performance of athletes in these events (22,24). The hammer throw, which follows a similar technical pattern to the weight throw, was examined in a cohort of US hammer throwers, and the results indicated that the athletes back squat 1RM was a significant predictor of performance (22).

The weight throw athletes not only need to have a sufficient background in resistance training to be able to technically execute the event but must also be prepared to deliver the maximum amount of impulse they are capable of producing during the completion of the release to be successful. Postactivation potentiation (PAP) has been demonstrated to cause acute enhancement of performance in athletes (1,3,5,6,20,33,35). Postactivation potentiation is an effect on muscle by which the contractile history of a muscle influences its present capacity. The likely mechanism behind the PAP is phosphorylation of the myosin regulatory light chains, which enhances the sensitivity of the actin-myosin complex to calcium ion release and thus enhances the contractility of the muscle fiber (10–12,15,30,34). For a review of PAP, see Sale (27).

Address correspondence to David Bellar, dmb1527@louisiana.edu.

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The PAP has been demonstrated in athletes to be an effective means of acutely augmenting performance (1,5,21,27,31,32). The method by which athletes can make use of the PAP effect is to perform a high force nonfatiguing activity before performing an athletic movement (27). This has included electrical stimulation (25), the use of weightlifting exercise to potentiate performance (14,23,29,37), and lighter load exercises such as warming up with a weighted vest before performing a jumping protocol (32). Postactivation potentiation is one technique through which athletes involved in the track and field throwing events can possibly increase their potential performance (1,5,18,19,21,31). Terzis et al. (31) examined the effects of performing drop jumps before an underhand shot put throw for distance in a group of track and field throws athletes. They reported that the PAP treatment enhanced the distance achieved during the underhand shot throw and that the effect of the PAP treatment was related to the percentage of type II muscle fiber. It has been reported that PAP effects are greater in individuals who possess higher percentages of type II muscle fiber (13). Therefore, it is likely that PAP could be related to the strength of the athletes, because hypertrophy of the type II muscle fiber would occur in athletes who have participated in the strength training that is common among track and field throwers (8).

The study that is most relevant to the present investigation involved the use of overweight implements for the warm-up of high school–aged weight throw athletes and examined the effects on subsequent throwing distance with the competition implement (21). The results of this study suggested that performing a warm-up with an implement that was 1.37 kg heavier than the one used for competition was an effective means of acutely enhancing performance. As with all studies on youth athletes, it is unclear if the results will translate to an older more experienced athletic population. Therefore, the present investigation was undertaken to determine if warming up with overweight implements would be an effective means of increasing performance in a group of collegiate and elite weight throwers and if the strength of these athletes had any relationship to the effectiveness of the treatments.

Methods

Experimental Approach to the Problem

A within-subject repeated-measures design was employed for the present investigation. The participants were tested for maximum distance thrown with a weight on 3 different days with at least 48 hours between trials. Each trial began with a warm-up protocol that included 15 minutes of general warm-up activities (skipping, dynamic mobility, etc.) followed by warm-up throws with 1 of 3 implements: the competition weight implement (STAND), an implement that was 1.37 kg heavier than the competition implement (OVRWGHT1), and an implement that was 2.27 kg heavier (OVRWGHT2). The order that the participants used these implements during the warm-up was randomized. After the warm-up, the participants performed 3 maximum effort 1 heel turn throws with the competition weight implements that were measured for distance. Information on current weightlifting 1RM (Back Squat and Power Clean) was provided at the time of this investigation by the athlete's coach.

Subjects

The institutional review board at Ball State University approved the present investigation. Before participating in the investigation, the subjects gave informed consent. The characteristics for the participants are given in Table 1. It should be noted that based upon the reported personal bests, the athletes who volunteered were all NCAA Division 1 athletes or elite competitors, and many were all conference performers or national qualifiers.

Procedures

The participants reported on 3 separate occasions to the practice complex for the local track and field team. On each occasion, the participants performed a preactivity warm-up protocol that consisted of approximately 15 minutes of active warm-up, which included drills, skipping exercises, and dynamic mobility exercise. Before performing any maximal effort attempts for distance, the participants performed a series of 5 warm-up 1 heel turn attempts with an assigned implement (treatment). The order of assignment of warm-up implement was randomized. The warm-up implements consisted of the competition weight (9.07 kg for women, 15.87 kg for men) implement (STAND), an implement that was 1.37 kg heavier than the competition implement (OVRWGHT1) and an implement that was 2.27 kg heavier (OVRWGHT2). The last of the warm-up throws constituted

Table 1. Participant characteristics.*†

Variable	Male (n = 9)	Female (n = 8)
Age (y)	20.8 ± 1.7	25.0 ± 4.6
Height (m)	1.91 ± 0.03	1.78 ± 0.10
Weight (kg)	117.0 ± 13.4	99.57 ± 25.6
Squat 1RM (kg)	234.1 ± 31.4	149.6 ± 33.6
Power clean 1RM (kg)	140.6 ± 21.8	99.6 ± 25.6
Weight throw PB (kg)	16.76 ± 2.12	20.54 ± 3.70

*1RM = one-repetition maximum; PB = personal best.
†Given as mean ± *SD*.

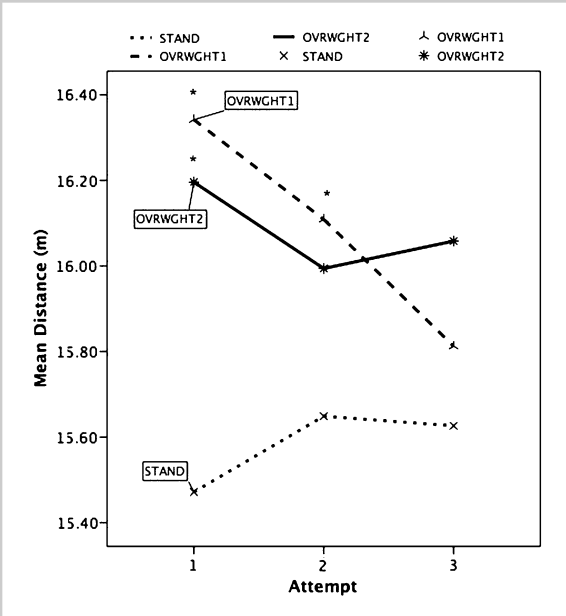

Figure 1. Mean distance for each treatment (STAND [regulation weight], OVRWGHT1 [1.37-kg overweight], OVRWGHT2 [2.27-kg overweight]) by attempt (1, 2, 3) listed in meters. *Significant difference from STAND ($p < 0.05$).

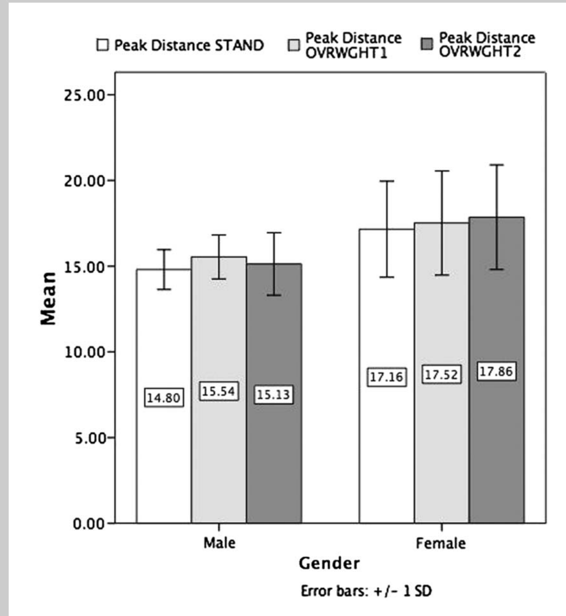

Figure 3. Peak distance for each treatment (STAND [regulation weight], OVRWGHT1 [1.37-kg overweight], OVRWGHT2 [2.27-kg overweight]) by gender listed in meters, error bars represent ±1*SD*.

the end of the warm-up period, at which point data collection began. At least 3 minutes of rest was given to the participants between each maximal effort attempt. A minimum of 48 hours passed between each trial.

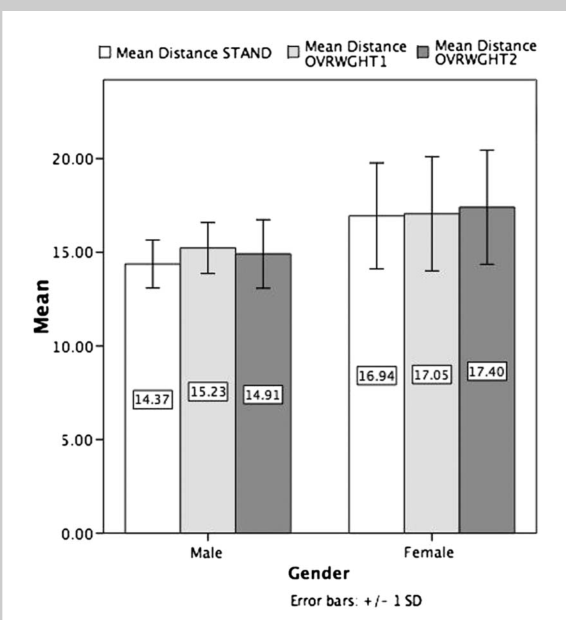

Figure 2. Mean distance for each treatment (STAND [regulation weight], OVRWGHT1 [1.37-kg overweight], OVRWGHT2 [2.27-kg overweight]) by gender listed in meters, error bars represent ±1*SD*.

Statistical Analyses

Descriptive data are reported as means and *SD*. Intraclass correlations were calculated for the distance measurements (intraclass correlation coefficient = 0.977). The results from the measured attempts were analyzed via repeated-measures analysis of variance (ANOVA) (Treatment × Time) and with paired samples *t*-test (corrected for multiple comparisons) to examine the differences in mean and peak distance attained for each treatment. Partial correlation analysis (controlled for gender) was used to compare 1RM strength values with the difference between treatments. The alpha level for significance was set a priori at $p < 0.05$. All statistical analyses were performed by using a statistics computer package (SPSS 17.0 for Macintosh).

Results

In examining the results of the measured attempts with the competition implement, the repeated-measures ANOVA revealed a significant main effects for Treatment ($F[2,32] = 5.418$, $p = 0.009$, $\eta_p^2 = 0.253$) but not for Time ($F[2,32] = 1.279$, $p = 0.292$, $\eta_p^2 = 0.074$). A significant interaction effect for Treatment × Attempt ($F[4,64] = 02.769$, $p = 0.035$, $\eta_p^2 = 0.148$) was found. Post hoc analysis (corrected for multiple comparisons) revealed that the first attempt for both OVRWGHT1 (OVRWGHT1 16.34 ± 2.6 vs. 15.47 ± 2.6 m, $p \leq 0.01$, ES = 1.49) and OVRWGHT2 (OVRWGHT2 16.19 ± 2.8 vs. 15.47 ± 2.6 m, $p \leq 0.01$, ES = 1.09) were significantly different from STAND (Figure 1). The second attempts under the STAND and OVRWGHT1 treatment

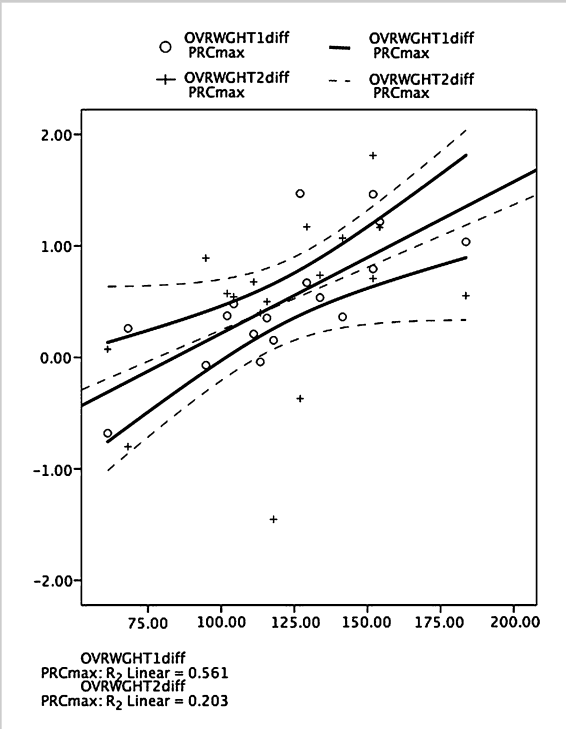

Figure 4. Scatter plot of change between STAND (regulation weight) and both OVRWGHT1 (1.37-kg overweight; solid line) and OVRWGHT2 (2.27-kg overweight; dashed line) by power clean one-repetition maximum. Arc lines represent the 95% confidence interval for the line of best fit.

were also significantly different (OVRWGHT1 16.11 ± 2.4 vs. 15.65 ± 2.4 m, $p = 0.007$, ES = 0.762). No other time points were found to be significantly different ($p > 0.05$).

Bonferroni-corrected paired samples *T*-test revealed that the means for the OVRWGHT1 treatment (16.08 ± 2.5 m) and OVRWGHT2 (16.08 ± 2.7 m) were not different ($p > 0.05$); however, the mean for STAND was significantly lower than that of the other treatments (15.58 ± 2.5, $p < 0.02$, ES > 0.8) (Figure 2). Paired sample *t*-test for peak distance by treatment revealed that both OVRWGHT1 (16.47 ± 2.42 m, $p = 0.002$, ES = 1.01) and OVRWGHT2 (16.41 ± 2.77 m, $p = 0.044$, ES = 0.619) were significantly different from STAND (15.91 ± 2.36 m) (Figure 3). However, there was no significant difference ($p = 0.768$, ES = 0.08) found between peak performance under the OVRWGHT1 and OVRWGHT2 treatments.

Differences in performance between OVRWGHT treatments and STAND (Figure 4) were found to correlate to 1RM Power Clean (improvement for OVRWGHT 1, $r = 0.536$, $p = 0.016$; improvement for OVRWGHT2, $r = 0.548$, $p = 0.014$). The 1RM Back Squat was not significantly related to the change from STAND under either the OVRWGHT1 ($r = 0.216$, $p = 0.421$) or OVRWGHT2 ($r = 0.234$, $p = 0.383$).

Discussion

The results of the present investigation are in agreement with the recent evidence for potentiation of weight throw performance through overweight implement warm-up in high school–aged athletes (21). The results showed that the mean and peak performance by the athletes subsequent to warming up with overweight implements was greater than when the warm-up was performed using the competition implement (Figures 2 and 3). The present investigation did not reveal any significant differences between the 2 overweight implements because both were essentially equal at producing an effect over a warm-up with the standard weight implement. There was a difference in the number of attempts at which the treatments produced a significant increase over the competition implement warm-up. The lighter of the 2 implements (+1.37 kg) used for warm-up resulted in a significant increase in performance on the first 2 attempts as compared with the heavier of the 2 (+2.27 kg), which was only different at the first attempt. This suggests that there might be some potential advantage in the use of the 1.37-kg overweight treatment for warm-up, though more investigation is warranted.

Judge et al.(21) used the same 2 overweight implement treatments as those found in the present investigation (+1.37 and +2.27 kg); however, the results of that study suggested that the +1.37-kg implement was more effective at producing a potentiation effect than was the +2.27-kg treatment. There are many reasons to account for this apparent difference. The most obvious is the difference in strength and training age between the athletes in the present investigation and those from the Judge et al. (21) study. The college and elite athletes in the present investigation had more experience and greater neuromuscular strength numbers than did those reported for the high school athletes in the previous study. Terzis et al. (31) examined the effect of potentiation of underhand shot put throws by drop jumps and reported a significant correlation between leg press strength and the effect of the drop jump on subsequent throwing performance. This finding suggests that strength levels do relate to the effectiveness of a PAP effect for throwing performance.

In addition to explaining the differences between the Judge et al. (21) study, the strength of the athletes in the present investigation was also significantly related to the difference between the mean throws subsequent to the overweight implement warm-up and the warm-up with the competition weight implement. This finding is in agreement with the Terzis et al. (31) article in that strength was positively correlated to performance under the PAP inducing treatments. In an investigation that assessed PAP effects in track and field athletes and 1RM strength, Bellar and Judge(1) reported that the potentiation effects of a heavy medicine ball throw on standing shot put throw distance was related to bench press strength. The relationship reported in this study was strong ($r^2 = 0.866$), and given that the average bench press of the participants was greater than 130 kg, it further suggests that stronger athletes, potentially with higher percentages of type II fiber, may be better suited to take advantage of PAP effects to increase performance in track and field throwing events.

Stone et al. (28) reported that power snatch strength was significantly related to performance in the group of collegiate throwers. This finding explains why the power clean was more related to the difference in performance between treatments in the present investigation and not to the back squat. The power clean is a lift similar to the snatch in that the weight is moved through a larger range of motion than is done for the squat at relatively higher speeds (9). Recent work by Fry et al. (8) related performance in Olympic-style weightlifting athletes to greater percentages of type IIa muscle fiber as compared with that of controls. The normal weight training of track and field throw athletes generally includes a mixture of Olympic-style movements and traditional squatting type exercise (2,4,7,16,17,36). These combinations of lifting movements are likely to result in the hypertrophy of type II muscle fiber over time. It would be logical to assume that the collegiate and elite athletes in the present investigation have spent a great deal of time in similar modes of strength training given their reported 1RM lifting values. Thus, these athletes should possess an increased amount of type II fiber, and likely, the strongest athletes have greater amounts. This would explain the relationship between the athletes' 1RM power clean and the potentiation effect from the present investigation.

Given the importance of relatively small changes in performance during a weight throw competition, where the difference in competitor placing is often determined by a matter of centimeters, the impact of an overweight implement warm-up before a competition could result in significant changes in the outcome for an athlete. Based upon the results of this study, and others in the area, it appears that if an athlete has trained enough to gain strength and likely greater percentages of type II muscle fiber, then the use of overweight implements for warm-up could potentially lead to an increase in performance.

Practical Applications

The results of the present investigation suggest that the use of an overweight implement warm-up for collegiate and elite weight throw athletes is an effective means of increasing performance. There was no significant difference demonstrated between the effects of the 2 different treatments; therefore, either may be used. Having demonstrated the effectiveness of both of the overweight implements to increase performance, coaches can create greater variety in employing PAP in their training plans. However, coaches should be advised that the strength level of the athlete is related to the effectiveness of the use of overweight implements and that weaker athletes will likely not benefit from this form of treatment. This would apply to all athletes new to the sport who have limited training ages, and therefore, the use of PAP with these athletes is not likely to produce good results. It is advisable for coaches to have their athletes who possess adequate strength levels warm up with overweight implements before competition if the director and officials of the meet are amenable to allowing this practice.

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