Effects of Preload 4 Repetition Maximum on 100-m Sprint Times in Collegiate Women

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Abstract

Linder, EE, Prins, JH, Murata, NM, Derenne, C, Morgan, CF, and Solomon, JR. Effects of preload 4 repetition maximum on 100-m sprint times in collegiate women. J Strength Cond Res 24(5):1184–1190, 2010—The purpose of this study was to determine the effects of postactivation potentiation (PAP) on track-sprint performance after a preload set of 4 repetition maximum (4RM) parallel back half-squat exercises in collegiate women. All subjects (n = 12) participated in 2 testing sessions over a 3-week period. During the first testing session, subjects performed the Controlled protocol consisting of a 4-minute standardized warm-up, followed by a 4-minute active rest, a 100-m track sprint, a second 4-minute active rest, finalized with a second 100-m sprint. The second testing session, the Treatment protocol, consisted of a 4-minute standardized warm-up, followed by 4-minute active rest, sprint, a second 4-minute active rest, a warm-up of 4RM parallel back half-squat, a third 9-minute active rest, finalized with a second sprint. The results indicated that there was a significant improvement of 0.19 seconds (p < 0.05), when the second sprint was preceded by a 4RM back-squat protocol during Treatment. The standardized effect size, d, was 0.82, indicating a large effect size. Additionally, the results indicated that it would be expected that mean sprint times would increase 0.04–0.34 seconds (p < 0.05), when using a preload 4RM squat protocol. There were no significant differences between Control pre and posttests (p > 0.05). The findings suggest that performing a 4RM parallel back half-squat warm-up before a track sprint will have a positive PAP affect on decreased track-sprint times. Track coaches, looking for the “competitive edge” (PAP effect) may re-warm up their sprinters during meets.

Key Words postactivation potentiation, warm-up, recovery

Introduction

Coaches are constantly searching for the optimum warm-up protocols to improve their athletes’ performances. Investigators have reported that sport-specific resistance warm-up increases performances in explosive activities such as baseball hitting and pitching (15,65). Similarly, recent investigators have reported that explosive jump performance increases after high-intensity (noncontrast or noncomplex training) preload resistance warm-up of a short duration (9,10,13,17,18,21,32,42,44,49,58). This temporary muscle-performance increase has been attributed to a phenomenon known as postactivation potentiation (PAP), a condition by which acute muscle force output is enhanced as a result of contractile history (43,47). In contrast, some investigators have reported jump-performance decreases (26,28,29,45,48) after preload high-intensity warm-up, which has been attributed to possible muscle fatigue.

Muscular fatigue negatively affects contractile history and impairs force production or power output (14,23,38,43,46), thus decreasing explosive performance within a certain time. Nevertheless, investigators have reported a coexistence of fatigue and PAP in skeletal muscle (43) and that muscle-performance enhancement after preload warm-up depends on the balance between muscle fatigue and muscle potentiation (20,34,47,54).

In addition to fatigue, there are other possible influences on PAP. It has been reported that the equivocal findings in recent PAP warm-up studies were possibly attributed to the fact that PAP is influenced by factors such as muscle-fiber type (22,25,46), performance level (21,57), training regimens (6,17), type of exercise (42,49), recovery time between preload stimulus and the dynamic performance testing (32), training experience (13,22,44), gender (13,17,19,44), and intensities (14). Although the mechanisms for eliciting PAP and subsequent improved performances are uncertain and needs to be further investigated, the 2 most reasonable underlying PAP mechanism theories include increased phosphorylation of light chain myosin and increased neurological factors in the spinal cord (1,45,47).

The majority of PAP warm-up studies have been conducted using jump performances with only a few studies investigating the effects on sport-specific performances (11,36,39,50).
These studies reported increased dynamic performance in competitive sports such as cycling and sprinting (11,22,25, 35,36,39,50). Chatzopoulos et al. (11) reported the influence of PAP on short-distance sprints of 10 and 30 m when performed by amateurs after heavy 10 single repetitions at 90% of 1 repetition maximum (1RM). McBride et al. (36) also reported a PAP presence with collegiate football players on 40-m sprint performances after a low-volume heavy squat warm-up consisted of 1 set of 3 repetitions at 90% of players’ 1RM. Although no numeric values were reported, Pfaff (39) found a significant increase in performances with elite sprinters performing a heavy resistance warm-up consisted of 90% of their 1RM for 5 sets of 1 repetition in the back-squat exercise. Elite rugby players had significantly improved 20-m sprint times after a preload back-squat warm-up that consisted of 1 set of 5RM (35). Smith et al. (50) reported a significant improvement in cycle sprint times using a modified Pfaff heavy-preload warm-up that consisted of 10 × 1 at 90% 1RM.

Although the results of these previous studies (11,35,36, 39,50) indicate a PAP effect after a preload heavy resistance warm-up on short-distance sprints and sprint cycling performances, to date, there is no known study on the PAP effects after preload warm-up on track middistance sprints of over 40 yards. Furthermore, to date, there have been limited studies examining PAP effects in women’s performances, and most of these studies have examined jumping (13,24,26,44). Based on these limitations, the purpose of this study was to determine the effects of PAP on 100-m track-sprint performance after a warm-up set of 4RM parallel back half-squat exercise in collegiate women. It was hypothesized that a heavy-preload squat warm-up protocol would have a positive PAP benefit on track-sprint times (<20 seconds) because Widrick et al. (56) reported that maximum voluntary contractions (MVCs) lasting ~10 seconds elicit the greatest PAP. The parallel back half squat was selected as the high-intensity exercise because peak functional augmentation is elicited better when using similar contraction types as the target movement (37).

**METHODS**

**Experimental Approach to the Problem**

The study examined the effects of a preload 4RM parallel back half-squat protocol on 100-m track-sprints speeds. The effects of the heavy-preload resistance warm-up will be assessed by using a 2-way within-subjects analysis of variance with a condition factor and time factor. To investigate the effects of preload warm-up on 100-m track sprints, the study will be conducted over a 3-week period as recommended by Chiu et al. (13). A stringent protocol was implemented to reduce the known confounders on preload effects.

**Subjects**

All the recreational women were required to (a) be injury-free, (b) have been participating in a resistance exercise program for at least 1 year with prior training experience in performing a loaded parallel back half-squat exercise, and (c) be currently enrolled in a Spring semester university weight training class.

All the collegiate subjects aged 20.83 ± 1.90 years volunteered to participate in this study and were informed of all risks, hazards, and benefits (see Table 1 for subjects’ demographics). To eliminate individuals with contraindications before their involvement in the research study, all subjects provided signed informed consent as approved by the university’s Institutional Review Board for Human Subjects. Nineteen subjects signed informed consent to participate in the study. Of the 19, 12 (63%) completed the entire 3-week protocol. All subjects were instructed to abstain from additional lower-body resistance training during the study period (35). In addition, all subjects were instructed to abstain from taking ergogenic aids (e.g., anabolic steroids, growth hormone, or any related performance-enhancing drugs). Subjects were not excluded if they were taking or had previously taken any vitamins, minerals, or related natural supplements (e.g., creatine monohydrate). However, subjects who were pregnant were excluded from the research study. A menstruation log was provided for all subjects to record the number of days since the beginning of their last menstrual cycle at the time of testing. During the 3-week study period, no menstrual cycles occurred in any subject.

**Procedures**

**Familiarization Sessions.** Before the beginning of the Familiarization period (Week 1), all subjects (n = 19) were instructed not to participate in resistance training 48 hours before all sessions (18). Subjects were also instructed to abstain from caffeine and alcohol for at least 12 hours before all sessions (18). All subjects attended the 3-alternate days of Familiarization during Week 1. During the first day of Familiarization, all subjects completed a written Informed Consent form, a Medical History Questionnaire, and a PAR-Q. Measurements of all subjects’ weights and heights were also recorded. The main objectives of Familiarization were to acquaint subjects with the 4-minute standardized warm-up, practice the parallel back half-squat exercise, and to determine and stabilize a true 4RM parallel back half-squat weight (48).

### TABLE 1. Subjects’ demographics (n = 12).

<table>
<thead>
<tr>
<th>Demographic variable</th>
<th>(Mean ± SD)</th>
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</thead>
<tbody>
<tr>
<td>Age (y)</td>
<td>20.83 ± 1.90</td>
</tr>
<tr>
<td>Height (in.)</td>
<td>63.58 ± 2.39</td>
</tr>
<tr>
<td>Weight (lb)</td>
<td>128.48 ± 18.73</td>
</tr>
<tr>
<td>4RM* load (lb)</td>
<td>137.50 ± 35.00</td>
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*4RM = 4 repetition maximum.*
All subjects were instructed to execute correctly the preload 4RM parallel back half-squat warm-up (13,35). The parallel back half-squat exercise was selected as the resistive exercise because it has been commonly used in studies as a lower-body stretch-shortening cycle movement (11,17,44,49,50,58). One set (22,58) of 4 repetitions of a 4RM was adopted as the resistive protocol because previous research indicated this preload stimulus was effective in enhancing acute lower-body power and has a lower injury risk than 1RM (22,42).

The 4-minute standardized warm-up protocol performed by all subjects consisted of pedaling at 70 rpm on a Cybex 700 cycle ergometer against a braking resistive force of 1 kg or 70 W (18,41). A 4-minute active rest followed the standardized warm-up. The 4-minute active rest was selected and mandatory for all subjects to assure adequate time to replenish energy stores (7,32).

After the 4-minute active rest, all subjects with the assistance of the investigators determined their 4RM equivalent for the Cybex Smith Press-Fixed Bar in accordance with National Strength and Conditioning Association’s (NSCA) 1RM testing protocol (3). In addition, the 4RM parallel back half-squat exercise applied the appropriate preload stimulus according to NSCA’s Percent of the 1RM and Repetitions Allowed (%1RM–repetition relationship) (3). Furthermore, the recovery time between the Familiarization sessions and the Control and Treatment sessions was a minimum of 5 days, which followed recommended protocols of 48-hour minimum necessary for muscle reconstruction (2,3).

Control Testing Sessions. Week 2, the Control sessions, consisted of all subjects randomly assigned to a specific session and performing individually, the 4-minute standardized warm-up, followed by a 4-minute active rest, a 100-m track sprint, a second 4-minute active rest, and a second 100-m sprint. The 4-minute active rest, each subject walked slowly around the track after each sprint, eliminating the possible fatigue effect (14,23,38). In addition, all subjects were assigned a proctor to assure that no additional warm-up activity or stretching was performed during the entire Control sessions, which might possibly interfere with force development and power output (30,33). Moreover, during the 100-m track sprint, all subjects were timed individually to eliminate the possibility of motivation. Furthermore, during Control and Treatment sessions, all subjects were also provided with a training log and were instructed to maintain their normal daily habits throughout the duration of the research study.

Treatment Testing Sessions. The Treatment sessions were similar as Control except after the first sprint and active rest, the Treatment condition was implemented with all remaining subjects \((n = 12)\) before the final 100-m sprint. Seven subjects were eliminated from the protocol because of outliers on the Treatment final 100-m sprint \((n = 2)\) and additional subjects declined further participation \((n = 5)\). Each subject was randomized and tested individually from the warm-up to the final 100-m sprint. Test–Retest reliability was conducted using Alpha (Cronbach) analysis between the precontrol and pre-experimental 100-m run times. The results indicated that the 100-m run time–dependent measure was very stable between tests (Cronbach’s Alpha = 0.941).

The Treatment condition consisted of a 4RM preload warm-up parallel back half-squat, followed by a third 9-minute (32) active rest and finalized with a second 100-m sprint. The 4RM preload warm-up established in the Familiarization period consisted of submaximal squats of \(1 \times 10\) at 60% and 85% (17,22,42), followed by \(1 \times 4\) predetermined 4RM with each subject approaching failure during the fourth repetition (35), which included a 2-minute rest between each of the 3 sets (13,50). In addition, according to Kilduff et al. (32), a 9-minute postactivation was within the 8–12 minutes suggested optimal recovery period to elicit a potential PAP effect. As in Control, during Treatment, a proctor was assigned to each subject.

The investigators were present for both the Control and Treatment testing sessions to assure that the environmental circumstances were the same for both testing sessions. During the sprints, investigators were present at every start to assure that all subjects adhered to all track start instructions, encouraged to sprint “all out,” sprint through the marked finished line, and that the “Speedtrap II” infrared timing system was operational (35). Each subject was timed individually to reduce a possible motivation effect. In addition, during the track-sprint start, all subjects were instructed to stand (no NCAA official track-sprint starts using standardized starting blocks were allowed) 0.5 m behind the start infrared timing Gates to assure no advantages in the sprint starts (35). At the start, during the sprint, and at the finish line, no biomechanical technique and motivation assistance was allowed.

Instrumentation

All track-sprint trials were performed on a Mondo outdoor and all weather track (Mondo USA, Lynnwood, WA), and all sprint times were measured by a “SpeedTrap II” infrared timing system (Brower Timing Systems, Draper, UT, USA). The photocells were positioned 1.5 m apart at each end of a 100-m track measured on an outdoor, all weather surface. Upon activation and termination, the “Speedtrap II” infrared timing system receiver emitted an auditory signal to indicate the start and stop of each sprint assessment.

A Cybex 700 cycle ergometer was used in performing the standardized 4-minute warm-up. In addition, a standard plastic goniometer (Prestige Medical, Los Angeles, CA) was used to measure the knee angle at 90° for the proper execution of the 4RM parallel back half-squat exercise (17,48). Furthermore, a Cybex Smith Press-Fixed Bar machine (13) was used in determining the 4RM parallel back half-squat exercise.
Statistical Analyses
Two subjects were excluded from the analysis after a lack of fit test was conducted and indicated that 2 subjects were outliers and did not adequately fit the predicted model (31). A 2-way within-subjects analysis of variance was conducted to evaluate the effect of a preload 4RM parallel back half-squat protocol on sprint speeds \( (n = 12) \). For all analyses, significance was set at an alpha level of \( p \leq 0.10 \). A priori because the effect of preload on sprint times is unequivocal, and very small increases in sprint times can have significant effect on outcomes.

RESULTS
A 2-way within-subjects analysis of variance was conducted to evaluate the effect of a preload 4RM parallel back half-squat protocol on sprint speeds. The dependent variable was 100-m sprint time measured at a hundredth of a second. The within-subjects factors were Condition with 2 levels (control and experimental) and Time with 2 levels (pre and post). The Condition and Time main effects and Condition and Time interaction were tested using the multivariate criterion of Wilks's lambda \( (\Lambda) \) (31). The Condition main effect, \( \Lambda = 0.89, F(1, 11) = 1.31, p = 0.28 \), and Condition and Time Interaction, \( \Lambda = 0.90, F(1, 11) = 1.20, p = 0.30 \), were nonsignificant. Significant differences were found for the Time main effect, \( \Lambda = 0.77, F(1, 11) = 3.24, p = 0.099 \), partial \( \eta^2 = 0.23 \). Two paired-samples \( t \) tests were conducted to follow up the significant Time main effect. Using the Bonferroni method, each paired sample \( t \) test was tested at the 0.05 level (0.10/2). Mean sprint times significantly increased 0.19 (\( \pm 0.23 \)) seconds, \( t(11) = 2.85, p = 0.016 \), from 17.140 (\( \pm 1.55 \)) seconds pretest to 16.948 (\( \pm 1.55 \)) seconds posttest in the experimental condition. The standardized effect size, \( d \), was 0.82, indicating a large effect size. The 95% confidence interval indicated that the mean sprint times should increase 0.04–0.34 seconds when using a preload 4RM squat protocol. Mean sprint times in the control condition did not significantly increase between pre (17.287 \( \pm 1.60 \)) and posttests (17.287 \( \pm 1.60 \)), \( t(11) = 0.73, p = 0.48 \).

DISCUSSION
This was the first study to investigate the effects of PAP on track-sprint performance after a warm-up of heavy-loaded exercises in collegiate women. The major findings indicated that there was a significant mean improvement of 0.19 seconds (1.2%) and that 82% of the variance was accounted for by this increase in sprint times when preceded by a 4RM back half-squat protocol.

The results of the present study were similar to other studies in men. Batista et al. (5) reported potentiated 1.3 N-m (\( \pm 0.79 \)) peak torque improvement in unilateral knee extensions in untrained adult men \( (n = 10) \). The intermittent exercise protocol was maintained for 12 minutes after the last contraction. Burkett et al. reported significant difference between the weighted jump warm-up and all 3 other warm-ups. The authors concluded that using a weighted resistance high intensity–weighted vertical box jumps warm-up protocol would produce the greatest effect when performing the vertical jump test. In addition, Chiu et al. (12) investigated acute neuromuscular fatigue and potentiation after 2 high-intensity power-training sessions (speed squats) on the same day with trained adult men \( (n = 12) \). The authors reported that (a) peak force was impaired 9.5% after training session 1 and 18.4% after training session 2; (b) initial rate of force development was depressed from PRE testing after session 1 and sessions 2; and (c) significant correlations between change score for initial rate of force development from session 1 to session 2 and myosin heavy chains (MHCs) I and IIa \( (r = 0.69) \) expression. The investigators suggest that the neuromuscular impairment performance after session 1 may be because of low-frequency fatigue, yet, for individual subjects with predominantly MHC IIa, session 2, appeared to induce PAP, resulting in the restoration of initial rate of force development. The similarities between these studies and the current study includes a (a) PAP effect, or (b) enhanced athletic performances.

To date, other than jump performances, there have been few heavy-preloaded resistance sport-specific warm-up studies that have reported similar significant improvements in sprint performances \( (11,35,36,39,50) \). Pfaff et al. (39) reported significant improvements in men's swim sprints. Matthew et al. (35) and McBride et al. (36) reported significant improvements of 3.3 and 0.87%, respectively, in men's short-distance (20 m; 40 m, respectively) track sprints. In addition, Chatzopoulos et al. (11) reported significant running-speed increases (0.03 and 0.02%) for selected running phases of 0–10 and 0–30 m, respectively, 5 minutes after a heavy-resistance stimulus. Furthermore, Smith et al. (50) also reported significant differences in average power and average power relative to body weight on a 10-second sprint cycle followed by a 5-minute recovery. It appears in the above and present sprint studies that PAP may be responsible for the significant improvements, and this PAP effect may be more prominent for dynamic (concentric contractions) than isometric contractions \( (21,25) \). Thus, findings \( (11,35,36,39,50) \) similar to those of the present study suggest that PAP could have potential benefits for athletes performing explosive sprints in swimming, track, and cycling. In addition, the present study supports previous research that it appears that there is a PAP effect after a preload heavy-resistance stimulus \( (9,13,22,24,32,35,39,40,42,48,53,58) \).

A preloaded resistance warm-up protocol before high-intensity activities such as various types of sprints improves mean power output \( (50) \). Maintaining high average power during sprinting events should transfer into faster times. Previous studies have reported that fatigue influences a decrease in force or power output \( (12,14,23,38) \). However, Smith et al. (50) reported that peak power and fatigue index did not significantly decrease with either a 5-minute or 20-minute rest recovery. Therefore, it is reasonable to assume
that in the present study the 4RM parallel back half-squat warm-up exercise did not elicit short-term anaerobic fatigue. The 2-minute rest period in between the squat exercises, and the 9-minute active rest recovery post-4RM squat exercise appears to have adequate time for ATP resynthesis.

Although there is paucity in PAP research with trained women as compared with men, the PAP mechanism for both may be phosphorylation of myosin light chains during MVC (21,27,52). In addition, if muscle hypertrophy and fast fiber-type conversions in resistance-heavy trained women are similar to those in men (51), then PAP effects within muscle may be also similar in women and in men. In addition, findings similar to the present study suggest stronger men and women may elicit greater PAP effects (17,22,32,44,58). Duthie et al. (17) reported a greater significant improvement in jump performances in stronger women after preload heavy-resistance warm-up. In addition, Kilduff et al. (32) and Young et al. (58) reported greater gains in jump performance with stronger resistance–trained athletic men after heavy-preload warm-up. Moreover, Gullich and Schmidblicher (22) reported a significant PAP response in the H-reflex for highly strength-trained male athletes as compared with physical education subjects. Furthermore, Rixon et al. (44) reported that experienced men and women weightlifters had significantly higher jump performances than did inexperienced subjects. It is still unclear as to the exact reason behind the relationship between strength and potentiation. However, it has been demonstrated that resistance trained men and women athletes have greater activation of the musculature involved during a preload high-intensity stimulus, which would affect the H-reflex and myosin regulatory light chain phosphorylation, the 2 mechanisms involved in PAP (12).

The results from this present study further indicate a PAP effect after the 9-minute recovery. Previous studies have determined the recovery period between the preload stimulus and the subsequent explosive performance activity ranging from 0 to 18.5 minutes for a phosphocreatine resynthesis after the preloaded warm-up (4,8,13,17,20,27,32,58). Kilduff et al. (32) reported that the optimal recovery to maximize the PAP effect on peak power output (PPO; ~7–8% increases) needed to be between 8 and 12 minutes for the lower body. In contrast, Jones and Lees (29) reported no significant differences in any of the performance variables measured after 3, 10, and 20 minutes of recovery after preload squats. In addition, Gilbert and Lees (18) reported equivocal acute effects after preloading with no significant differences between pre and postweightlifting assessment of maximum isometric rate of force development (iRFD) at 2- and 10-minute recovery; in contrast, significant increases were reported at 15- and 20-minute recovery representing a functional peak increase of 11.8% after preload repeated maximum strength (5× at 1RM) back squats. Furthermore, Gilbert and Lees (18) also reported significant increases in iRFD and vertical jump height (6.7%, ~3%, respectively) at 2 minutes of recovery after a repeated maximum power (5× at maximum power) back squats, and significant increases (~9%) in vertical jump performance peaking at 20 minutes after preload repeated maximum strength back squats. These investigators’ findings further suggest that PAP elicits increased force development capability after high-intensity exercise warm-up and the temporal profile of PAP changes with the intensity of the exercise used to induce it (18). Furthermore, when one considers whether the sprinters’ times improved or decreased from T1 pretest to T2 posttest, 10 of the 12 sprinters’ times improved. Thus, in general, an improvement in sprint times from T1 pretest to T2 posttest suggests the possibility that the preload warm-up could have contributed to that improvement resulting in a PAP effect. However, it is also possible that the improvement could have simply been because of the warm-up sprint. If improvement was because of the warm-up sprint, then the sprint times for C1 pretest and C2 posttest should show a similar pattern. A comparison of the means listed in for these times yielded no significant difference indicating that the mean for C1 pretest (M = 17.29) was not significantly different from the mean for C2 posttest (M = 17.21). The frequency of improved vs. decreased times from C1 pretest to C2 posttest was exactly as expected if there were no effect because of the first sprint: 6 improved and 6 decreased (chi-squared = 0.00).

Although not unequivocal, these results suggest that the PAP warm-up may result in a significant improvement in sprint times for the 100-m sprint. Because the PAP warm-up did not result in all sprinters improving their times, there is the possibility that there are individual differences and particular conditions that need to be considered. Thus, PAP warm-up may not be appropriate for every sprinter. Additional research is necessary to determine for whom and under what conditions the PAP warm-up should be recommended as part of a presprint regimen.

In conclusion, the results of the present study indicate that (a) a PAP effect was probably responsible for significant increases in track-sprint performances similar to other recent sprint studies (11,35,36,39,50) and (b) strong athletic-trained collegiate women revealed significant improvements in track sprints similar to trained men after a PAP intervention of heavy-preload resistance warm-up. In addition, the present study supports the Kilduff et al. (32) study that suggests that the optimal recovery period to maximize the PAP effect on PPO activities such as sprint and jump performances appears to be between 8 and 12 minutes for the lower body.

**Practical Applications**

The current findings indicate that if track-sprint coaches are warming up their sprinters before the competitive track meet, it is advised that they re-warm up their sprinters as a means to increase their players’ power with a preload back half-squat exercise. Based on the totality of studies, the preload warm-up should be between 8 and 12 minutes of recovery before the sprint events to obtain the greatest PAP benefit. In addition,
coaches should be aware that individual responses exist in terms of optimal recovery for PPO after a preload stimulus. Therefore, track coaches should individually determine their players’ optimal recovery for PPO to improve sprint times.

Interestingly, the results of the last women’s 100-m track-sprint finals in the 2004 Olympic Games suggest that an individualized PAP warm-up may have changed the outcome. The top 6 places were as follows: 10.93, 10.96, 10.97, 11.00, 11.05, and 11.07 seconds. The difference in the top 3 medalists was only 0.04 seconds. In addition, the difference between the third place bronze medal winner and sixth place finisher (finishing out of the medal finalists) was between 0.03 and 0.1 seconds. Because of the extremely small differential in times of the 6 finalists, the event had a photo finish to determine the ranking of the 100-m finish. In addition, although previous investigators have reported equivocal findings in recent PAP warm-up studies, all 5 PAP swim, cycle, and track-sprint studies (11,35,36,39,50), including this present study, have reported significant improvements in sprint performances with distances of 100-m or less after a heavy-preloaded (high-intensity) resistance sport-specific warm-up. Furthermore, collectively, the previous 4 sprint studies reported sprint improvements of 0.89–3.3% including the present study of 1.1% with trained explosive athletes. Thus, in all of the only 5 sprint warm-up studies to date, PAP may be responsible for the significant sprint improvements. Therefore, if any one of the women in the past 100-m finals of the 2004 Olympic Games performed a heavy-preloaded resistance warm-up between 8 and 12 minutes before the event, the medal outcome may have been different.

Furthermore, amateur high-school, collegiate, and professional track-sprint coaches may use the “home field advantage” in eliciting a PAP effect. All home amateur and professional coaches and athletes know the times of the running and field events on competitive meet days. If possible, these highly competitive coaches looking for the “competitive edge” (PAP effect) should escort their respective sprint athletes into the closest weight room to perform a heavy-resistance preload warm-up between 8 and 12 minutes before their athletes’ scheduled events to effectively reduce sprint times.

**REFERENCES**

Effects of Preload


