THE EFFICACY OF MANIPULATIVE WEIGHT TRAINING ON THE STARTING DYNAMICS AND SPRINTING ABILITY OF ELITE SPRINTERS

Dr. Susanta Kumar Panda
Senior Sports Officer, Indian Institute of Technology, Kharagpur
Email: skpanda@adm.iitkgp.ac.in

Abstract: The purpose of the present study was to determine the effect of structured manipulation of weight training on the sprinting ability and block start mechanics of elite sprinters. Thirty male sprinters (N = 30, age: 22.5 ± 0.2 years, height: 1.82 ± 0.02 m, body mass: 66.5 ± 5.4 kg) from the Lakshmibai National Institute of Physical Education, NERC, volunteered to participate. Subjects were randomly assigned into two equal cohorts (n = 15 per group): Group A (Experimental Manipulative Weight Training) and Group B (Control). The experimental group underwent a highly structured Olympic lifting and weight training program three times a week for six weeks, with loads progressively manipulated from 50% to 60% of one-repetition maximum (1 RM). The control group maintained their routine training activities. Sprinting performance was quantified using the Smart Block system integrated with an Instant Feedback software application. Kinematic and kinetic parameters including Run Time, Raw Time, Reaction Time, Left/Right Peak Pedal Forces, Push Time, and distance-targeted Timed Runs were precisely monitored. Intragroup changes were assessed via paired-samples t-tests. The experimental group demonstrated statistically significant improvements across all analyzed starting metrics ($p <= 0.05$): Run Time ($t = 3.02$), Raw Time ($t = 3.05$), Reaction Time ($t = 5.86$), Right Peak Force ($t = 4.42$), Left Peak Force ($t = 3.84$), Push Time ($t = 2.50$), and Timed Runs ($t = 2.95$), exceeding the critical threshold of $t\_0.05(14) = 2.145$. No significant changes were observed in the control group ($p > 0.05$). The findings indicate that the systematic manipulation of intensive multi-joint resistance programs enhances neural recruitment, explosive starting block drive, and aggregate acceleration profiles in elite sprinters.

Keywords: Weight Training, Olympic Lifting, Sprinters, Sprinting Ability, Smart Block, Biomechanics.

1. Introduction

Modern athletic preparation requires a scientifically grounded approach supported by specialized equipment and validated training methodologies to maximize physical expression in competitive sports. Achieving peak human athletic performance requires input from multiple sports science disciplines working in close harmony to decode the biological and mechanical processes that govern rapid force generation (Rachna, 2001; William, 1980). Systematic conditioning has evolved over centuries, changing from ancient military preparation into a field guided by data analytics and periodization protocols (Tudor, 1999). Recently, sports scientists have focused on the quality and neurological specificity of training stimuli rather than simply increasing workload volume. This shift helps maximize performance adaptations while minimizing physical strain and injury risks (Asha, 1980).

In power-oriented tracking events, sports scientists heavily emphasize developing ballistic force output and refining initial block clearance mechanics. Common methodologies used to build lower-body power include plyometrics, resisted or assisted running models, and localized acceleration drills. Within the weight room, Olympic lifting derivatives—such as power cleans, snatches, push presses, and jerks—are popular tools used to develop explosive neural drive. However, the direct transfer of these multi-joint exercises to the unique demands of block clearance continues to be a key area of study in sports biomechanics (Takano, 1992). While Olympic lifts build general vertical and horizontal power, starting block clearance requires an immediate transition from static hip flexion to explosive extension along a low horizontal plane.

Historically, analyzing the absolute start phase was limited by manual timing methods, which lacked the sensitivity needed to capture brief force transitions. The introduction of smart technologies has changed this diagnostic process. Current tool arrays, like the Smart Block system, use built-in force-plate sensors and synchronized audible signaling to isolate distinct components of the start. This technology partitions the start into precise elements: reaction latency, left/right peak block forces, pedal push duration, and segmented stride execution times. This automation gives coaches and sports scientists immediate access to objective, actionable data to optimize an athlete's block angles and early acceleration path. This study evaluates how a six-week program of manipulative weight training affects these specific start components in elite university sprinters.

2. Methodology

2.1 Experimental Design and Subjects

A sample of thirty (N = 30) elite male sprinters was selected using purposive sampling from the Lakshmibai National Institute of Physical Education, NERC, Assam. The physiological baseline profile of the sample was: Age (22.5 ± 0.2 years), Height (1.82 ± 0.02 m), and Body Mass (66.5 ± 5.4 kg). Following an explanation of the experimental risks and research objectives, all participants provided written informed consent. The participants were randomly split into two equal groups (n = 15 per group): the Experimental Weight Training Group (Group A) and the Control Group (Group B). Group A performed the prescribed manipulative resistance program, while Group B maintained their regular daily training schedule.

2.2 Device Instrumentation and Kinematic Metrics

The starting profiles and initial acceleration parameters were quantified using the Smart Block platform integrated with the Instant Feedback application. This electronic system uses instrumentation plates within the foot blocks to automatically capture kinetic and kinematic performance values, including:

- • Run Time (s): The total duration of the targeted sprint segment, used to assess whether technique modifications improve overall time.
- • Raw Time (s): The true running duration computed from the first physical movement off the pedals, excluding individual reaction latency.
- • Reaction Time (s): The precise time delay between the automated starter gun sound and the athlete's initial force application against the pedals.
- • Peak Force (Right / Left) (lbs): The maximum absolute force generated against the right and left block pedals during the initial extension phase.
- • Push Time (s): The exact duration of continuous force application against the block pedals before foot clearance.
- • Timed Runs (s): Electronic photo-beam timers set at specific track distances to log exact velocity maintenance across target acceleration spans.

2.3 Weight Training Intervention

The experimental cohort (Group A) completed a six-week resistance program performed three times weekly on alternating days (Monday, Wednesday, and Friday). The program focused on explosive Olympic lifts and foundational derivatives. Workloads were calculated relative to each participant's individual 1RM, determined at the start of the study. The program structure was divided into two distinct, three-week training blocks:

- • Weeks 1–3: Participants performed three sets of 10–15 repetitions at 50% of 1RM, with a strict 3-minute rest interval between sets to prioritize movement speed and volume accumulation.
- • Weeks 4–6: Intensity was increased to 60% of 1RM, reducing the volume to 10–12 repetitions across three sets, with recovery intervals shortened to 2 minutes between sets to increase neuromuscular density.

Table 1: Six-Week Progressively Manipulated Weight Training Matrix

S.No.	Core Multi-Joint Exercises	Weeks 1-3 Loading	Rest (min)	Weeks 4-6 Loading	Rest (min)
1	Power Clean	3 Sets x 10-15 Reps @ 50% 1RM	3	3 Sets x 10-12 Reps @ 60% 1RM	3
2	Romanian Dead Lift	3 Sets x 10-15 Reps @ 50% 1RM	3	3 Sets x 10-12 Reps @ 60% 1RM	3
3	Hang Clean	3 Sets x 10-15 Reps @ 50% 1RM	3	3 Sets x 10-12 Reps @ 60% 1RM	3

4	Split Jerk	3 Sets x 10-15 Reps @ 50% 1RM	3	3 Sets x 10-12 Reps @ 60% 1RM	3
5	Clean Push Press	3 Sets x 10-15 Reps @ 50% 1RM	3	3 Sets x 10-12 Reps @ 60% 1RM	3
6	Hang Snatch	3 Sets x 10-15 Reps @ 50% 1RM	3	3 Sets x 10-12 Reps @ 60% 1RM	3

3. Statistical Analysis

Data were analyzed using descriptive parameters (mean values) and inferential tracking models. Independent and paired-samples t-tests were executed to determine within-group and between-group changes from pre-intervention to post-intervention. Statistical significance was established a priori at an alpha level of $p <= 0.05$. With 14 degrees of freedom ($df = 14$), the critical tabular t-value needed to reject the null hypothesis was set at 2.145.

4. Results

The statistical analysis shows that the experimental group achieved significant changes across all seven variables. The calculated t-values for the experimental group all exceeded the critical value of 2.145. In contrast, the control group showed no statistically significant variations across any of the starting block metrics over the intervention period ($p > 0.05$).

Table 2: Intragroup Pre- and Post-Test Metric Comparisons (N=30)

Variables	Exp (Pre)	Exp (Post)	t-value (Exp)	Ctrl (Pre)	Ctrl (Post)	t-value (Ctrl)
Run Time (s)	2.53	2.52	3.02*	2.53	2.53	0.79
Raw Time (s)	0.19	0.18	3.05*	0.13	0.13	0.57
Reaction Time (s)	2.39	2.30	5.86*	2.40	2.38	1.78
Peak Force - R (lbs)	27.47	23.48	4.42*	27.13	28.53	1.14
Peak Force - L (lbs)	52.26	59.24	3.84*	52.40	56.26	1.67
Push Time (s)	0.12	0.13	2.50*	0.148	0.159	1.33

Timed Runs (s)	0.17	0.19	2.95*	0.167	0.186	1.93

5. Discussion

The statistical results show that targeted, multi-joint resistance programming can significantly modify starting block dynamics and initial acceleration parameters in elite sprinters. In competitive sprinting, where races can be decided by fractions of a second, block clearance efficiency provides a critical performance advantage. The data indicates that if regular training factors remain constant among sprinters, the athlete who generates the highest horizontal power out of the blocks establishes a decisive early lead. Achieving this requires high extension velocity alongside stable, balanced positioning in the 'Set' configuration.

The experimental data reveals changes in bilateral block force distribution, with peak force on the left pedal increasing from 52.26 lbs to 59.24 lbs. This shift shows that Olympic lifting derivatives help sprinters optimize bilateral leg drive, allowing them to push more powerfully against the pedals. The multi-joint, high-velocity movements required by exercises like power cleans and snatches train the nervous system to coordinate fast motor unit recruitment. This improved neural coordination supports explosive extension through the hips, knees, and ankles during block clearance (Takano, 1992).

Furthermore, the decrease in Reaction Time from 2.39 s to 2.30 s ($t = 5.86$) shows that ballistic resistance training can shorten the time required to initiate movement after an audible stimulus. This adaptation is likely driven by enhanced motor cortex excitability and faster efferent signaling from the alpha motor neurons to the target muscle groups. The corresponding improvements in Raw Time ($t = 3.05$) and Push Time ($t = 2.50$) further confirm that the experimental group generated higher rate of force development (RFD) values. This increased power output allows sprinters to drive off the block face more rapidly and efficiently translate horizontal forces into the early acceleration phase.

6. Conclusion

In conclusion, the present study suggests that a six-week program of manipulative weight training, using targeted progressions from 50% to 60% of 1RM, significantly improves starting block metrics and early acceleration mechanics in elite sprinters. The intervention produced measurable adaptations in response speed, pedal force application, and stride clearance times. These results provide sports scientists and track coaches with empirical evidence supporting the use of Olympic lifting progressions to optimize neuromuscular drive and block clearance efficiency in competitive sprinters.

References

Bompa, T. O. (1999). Periodization: Theory and Methodology of Training (4th ed.). Champaign, IL: Human Kinetics Publications, pp. 3-4.

Freeman, W. H. (1980). Physical Education and Sports in a Changing Society. New Delhi: Surjeet Publications, 10, pp. 12-13.

Jain, R. (2001). Physical Education. New Delhi: Sports Publications, 11, p. 2.

Patel, A. H. (1980). The effect of varied frequencies of speed training on sprinting speed (Unpublished master's thesis). Jiwaji University, Gwalior, p. 3.

Takano, B. (1992). Resistance Exercise: The Power Clean - Perspectives and Preparation. National Strength and Conditioning Association Journal, 14(1), pp. 68-71.

Corresponding Author

Dr. Susanta Kumar Panda
Senior Sports Officer, Indian Institute of Technology, Kharagpur
Email: skpanda@adm.iitkgp.ac.in