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COMPARISON OF HEAVY SLED LOADS SPRINT TRAINING VERSUS PLYOMETRICS ON EXPLOSIVE POWER AND SHORT SPRINT PERFORMANCE AMONG SPRINTERS

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ABSTRACT

Background: Explosive power and short sprint performance are essential components for success in sprinting events and many athletic activities. Various training methods such as heavy sled load sprint training and plyometric training are widely used to enhance these physical qualities. Heavy sled training focuses on improving force production and acceleration, whereas plyometric training enhances the stretch-shortening cycle, leading to better power output and neuromuscular coordination. However, there is limited evidence comparing the effectiveness of these two training methods over a short duration among sprinters. Therefore, the aim and objective of the study was to compare the effect of heavy sled load sprint training and plyometric training on explosive power and short sprint performance among sprinters. **Methodology:** A total of 30 male sprinters aged 18–24 years were selected and randomly divided into two groups: Group A (heavy sled load training) and Group B (plyometric training). The training was conducted for 4 weeks, 3 sessions per week. Vertical jump test and 30-meter sprint test were used for assessment. **Results:** Both groups demonstrated statistically significant improvements in vertical jump performance and 30-meter sprint performance following the 4-week training program. This indicates that both heavy sled load training and plyometric training are effective in enhancing explosive power and sprint ability. On comparison between the groups, the plyometric training group showed greater improvement than the heavy sled load training group. **Conclusion:** Both heavy sled load sprint training and plyometric training are effective methods for improving explosive power and short sprint performance among sprinters. However, plyometric training appears to be more effective in producing greater improvements over a short period of time.

KEYWORDS: Plyometric training, Heavy sled load training, Explosive power, Sprint performance.

INTRODUCTION

Athletics is one of the most popular sports worldwide. Athletic performance is influenced by several physiological processes, particularly the nervous system's ability to regulate the functions of various body systems and organs.[1,2] Sprint running speed is an essential component of physical fitness in many team sports such as soccer, rugby, and basketball. Improving sprint acceleration ability, is highly important because most sprints during games last only a few seconds, typically covering distances of about 10–20 meters or lasting approximately 2–3 seconds.[3]

Sprint speed plays a vital role in successful performance across many sports, highlighting the need to evaluate whether heavy sled pulling can induce a post-activation potentiation (PAP) response.[5] In fact, the average duration of sprints during a game is usually between 2 and 4 seconds. Since short-distance acceleration occurs repeatedly in many field-based sports, focusing on the development of this phase may be more beneficial than emphasizing maximum velocity development, except in sports that specifically require top speed performance.[4] A sprint is a track and field activity that involves running over a short distance at maximum speed. It highlights an athlete's explosive power, acceleration, efficient running technique, and the neuromuscular system's ability to rapidly alternate between activation and relaxation.[6] Sprinting is a powerful movement in which the muscles of the lower limbs generate large amounts of vertical and horizontal force with each step.[10]

Sprint performance is influenced by both the athlete's physical capacity and technical ability to apply this capacity effectively during running.[10] Successful sprinting requires the optimal integration of neuromuscular coordination, muscular strength, elastic energy utilization, and the stretch-shortening cycle (SSC).[1] Among the various factors contributing to sprint success, explosive power is considered a critical determinant of performance. Explosive power refers to the ability to produce a high level of muscular force within a very short period of time, which is essential for sprinting events and other high-intensity athletic activities.[7]

Sprint athletes require a complex combination of maximal strength, elastic power, and neuromuscular reactivity, which together support efficient sprint mechanics and performance.[1] Therefore, training methods that effectively develop these physical qualities are essential for improving sprint performance. Modern sprint training programs strongly emphasize strength training because improvements in muscle strength and power can significantly enhance mechanical efficiency, muscular coordination, motor unit recruitment patterns, and the stiffness of muscles and tendons. These physiological adaptations help develop specific strength in the key muscle groups necessary for successful sprint performance.[6]

While sprint practice itself remains the most specific and effective method for improving sprint performance, additional training approaches such as weight training, plyometric exercises, flexibility training, and assisted sprinting are also commonly used to enhance sprint acceleration and overall sprint ability.[3] Research in sports science suggests that training exercises that closely resemble the movement patterns of sport-specific actions may produce greater transfer of physical improvements to actual performance.[10]

For this reason, many strength and conditioning programs incorporate training methods that mimic the biomechanical characteristics of sprinting and explosive movements. Sprint running requires explosive muscle contractions and high mechanical forces, which increase the risk of injuries among sprinters. Common injuries reported in sprint athletes include hamstring strains, muscle strains of the thigh, knee injuries, and Achilles tendon problems. Hamstring injuries are particularly frequent in sprint events due to the high forces generated during high-speed running.

Sprint acceleration is a crucial factor in overall sprint performance. Speed during the acceleration phase is strongly associated with maximal sprint velocity and significantly influences performance in events such as the 100 m sprint. The effectiveness of acceleration technique affects the distance required to reach maximal speed, the ability to maintain that speed, and overall speed endurance.[9] Weighted sled towing with heavy loads may enhance sprint acceleration performance by encouraging athletes to generate greater horizontal or resultant ground reaction force (GRF) impulses.[5]

To improve sprint acceleration and performance, several training methods have been developed. These methods aim to produce both immediate and long-term improvements in sprinting ability.[9] One commonly used method is resisted sprint training using sled towing. During sled towing, athletes sprint while pulling a weighted sled, which increases resistance and enhances force production. The movement pattern, stride frequency, and muscle activation during sled towing closely resemble the technical characteristics of the sprint acceleration phase, making it an effective training method for improving acceleration mechanics.[9]

In many studies, sled towing resistance is prescribed as a percentage of the athlete's body mass (BM). This method is commonly used because body mass is considered an important factor influencing the athlete's ability to generate muscular force.[9] Recent research has increasingly focused on the use of heavier resisted sled loads to improve sprint acceleration. Studies have shown that sled loads ranging from 30% to 75% of body mass can improve sprint kinematics and sprint performance. In particular, heavier loads such as 50% body mass have been used to examine potential neuromuscular adaptations that may enhance sprint acceleration performance.[9]

Therefore, this study aims to examine whether heavier sled loads influence the kinematic characteristics of the acceleration phase (0–30 m) and improve sprint performance over 30 m and 60 m distances in adolescent sprinters. It is hypothesized that sled training with 40% and 50% body mass loads will produce significant improvements in sprint acceleration and sprint performance.[9]

Plyometric training (PT) is a form of strength training that mainly involves explosive movements such as jumping, hopping, skipping, and throwing exercises. These movements closely resemble many sport-specific actions, including high jumping, pitching, and kicking. Because of this similarity to athletic movements, plyometric training is widely used in many sports and may even be more effective than some traditional resistance training methods in improving performance.[8]

A key characteristic of plyometric training is the use of the stretch-shortening cycle (SSC). The SSC occurs when a muscle rapidly changes from an eccentric contraction (muscle lengthening or deceleration phase) to a concentric contraction (muscle shortening or acceleration phase). This rapid transition allows the body to store elastic energy during the eccentric phase and release it during the concentric phase, resulting in greater force production and movement efficiency.[8]

Through this SSC mechanism, plyometric exercises help athletes develop explosive power, which is essential for improving sport-specific skills. By effectively utilizing the stored elastic energy and neuromuscular coordination, athletes can enhance performance in activities that require quick and powerful movements.[8]

Because plyometric exercises directly rely on the stretch-shortening cycle, they are expected to produce greater improvements in activities that require rapid force production and elastic energy utilization.[1] In addition, plyometric training follows natural human movement patterns and transforms elastic potential energy generated during the eccentric phase into kinetic energy during the concentric phase, thereby improving explosive power.[7]

Plyometric training can also stimulate post-activation potentiation (PAP) along with the SSC, which further contributes to improvements in explosive power and muscular strength.[7] Moreover, research evidence indicates that plyometric training promotes neuromuscular adaptations and increases muscle strength, although the effectiveness may depend on factors such as training experience, recovery duration, and the use of additional resistance during exercises.[11]

Overall, plyometric training consists of quick and powerful actions in which muscles rapidly lengthen and immediately shorten. Studies have shown that this type of training provides a moderate advantage in improving power and sprint speed performance.[12]

Despite its widespread use among sprinters, the effectiveness of plyometric training in improving explosive power still requires further investigation due to inconsistent findings and limited sport- specific comparative studies. Therefore, examining the impact of plyometric training on explosive power and sprint performance remains an important area of research.[1]

MATERIALS AND METHODS

The present study was an experimental study aimed to compare the effect of heavy sled load sprint training and plyometric training on explosive power and short sprint performance among sprinters. Sample size of 30 was taken for the study based on inclusion and exclusion criteria. The inclusion criteria for the study were male sprinters aged from 18-30 and had at least 3 years of sprint training experience with no injuries or medical conditions affecting their performance. Complete assessment was done. Subjects who have been found suitable to participate were explained the nature of the study. They were divided into two groups by convenient sampling method (Group A = 15, Group B = 15).

WARM UP (10 Minutes): It includes Jogging, hamstring stretch, quadriceps stretch, calf stretch, side lunge, A-Skips and high knees. Rest interval was 1-2 minutes between sets and 2 minutes between exercises to avoid fatigue and to maintain performance quality.

GROUP A – HEAVY SLED LOAD TRAINING

Week 1

Forward Sled Drag – 3 × 20 m Backward Sled Drag – 3 × 20 m Hand-over-Hand Sled Pull – 3 × 15 m Resisted Sprint with Sled – 3 × 15 m Sled Acceleration Sprint – 3 × 20 m

Week 2

Forward Sled Drag – 4 × 20 m Backward Sled Drag – 4 × 20 m Hand-over-Hand Sled Pull – 3 × 20 m Resisted Sprint with Sled – 4 × 20 m Sled Acceleration Sprint – 4 × 20 m

Week 3

Forward Sled Drag – 4 × 25 m Backward Sled Drag – 4 × 25 m Hand-over-Hand Sled Pull – 4 × 20 m Resisted Sprint with Sled – 5 × 20 m Sled Acceleration Sprint – 4 × 25

Week 4

Forward Sled Drag – 5 × 25 m Backward Sled Drag – 5 × 25 m Hand-over-Hand Sled Pull – 4 × 25 m Resisted Sprint with Sled – 5 × 25 m
Sled Acceleration Sprint – 5 × 30 m

Fig. 1: Backward Sled Drag.

Fig. 2; Hand Over Hand Sled Pull.

Fig. 3: resisted sprint with sled.

Fig. 4: forward sled drag.

Fig. 5: sled acceleration sprint.

GROUP B – PLYOMETRIC TRAINING

Week 1

Bounding – 3 × 20 m Split Jumps – 3 × 10 reps Lateral Hops – 3 × 10 reps

Multiple Response Jumps – 3 × 8 reps Power Skips – 3 × 20 m

Week 2

Bounding – 4 × 20 m Split Jumps – 4 × 10 reps Lateral Hops – 4 × 12 reps

Multiple Response Jumps – 4 × 10 reps Power Skips – 4 × 20 m

Week 3

Bounding – 4 × 25 m Split Jumps – 4 × 12 reps Lateral Hops – 4 × 15 reps

Multiple Response Jumps – 4 × 12 reps Power Skips – 4 × 25 m

Week 4

Bounding – 5 × 25 m Split Jumps – 5 × 12 reps Lateral Hops – 5 × 15 reps

Multiple Response Jumps – 5 × 12 reps Power Skips – 5 × 30 m

COOL DOWN (5 minutes): It includes Follow the stretching for 15 seconds on both the side.

RESULTS

In Table 1, On comparing mean values of GROUP-A and GROUP-B on Vertical Jump Test scores shows highly significant improvement in the post test mean but GROUP-B shows (67.47) greater mean value is more effective than GROUP-A (61.00) at P≤0.001, Hence the null hypothesis is rejected.

In Table 2, On comparing mean values of GROUP-A and GROUP-B on 30M Sprint Test score shows highly significant improvement in the post test mean but GROUP-B shows (4.10) greater mean differences is more effective than GROUP-A (4.19) at P≤0.001, Hence the null hypothesis is rejected.

In Table 3 & 4, On comparing Mean Values of Vertical Jump Test and 30M Sprint Test scores between pre test and post test within Group-A and Group-B shows highly significant difference at p≤ 0.0001. Hence the null hypothesis is rejected.

Table 1: Comparison Of Vertical Jump Test Score Between Group - A And Group - B In Pre Test And Post Test.

VERTICAL JUMP TEST	GROUP A		GROUP B		t-TEST	SIGNIFICANCE
	MEAN	SD	MEAN	SD		
PRE TEST	57.80	5.93	59.07	6.75	0.54	0.58
POSTTEST	61.00	6.00	67.47	7.34	2.64	0.01

The above table reveals the Mean, Standard Deviation (S.D), t-test and p-value of the Vertical Jump Test score between (Group A) & (Group B) in pre test and post test.

This table shows that there is no significant difference in pre test values of the Vertical Jump Test score between Group A & Group B.

This table shows that there is a significant difference in post test values of the Vertical Jump Test score between Group A & Group B.

Both the group shows significant increase in the post test means but (GROUP-B) which has the greater mean value is more effective than (GROUP-A). Hence the null hypothesis is rejected.

Table 2: Comparison of 30m sprint test score between group - a and group - b in pre test and post test.

30M SPRINT TEST	GROUP A		GROUP B		t-TEST	SIGNIFICANCE
	MEAN	SD	MEAN	SD		
PRE TEST	4.27	0.12	4.29	0.10	0.49	0.62
POST TEST	4.19	0.13	4.10	0.08	2.29	0.00

The above table reveals the Mean, Standard Deviation (S.D), t-test and p- value of the 30M Sprint Test score between (Group A) & (Group B) in pre test and post test.

*This table shows that there is no significant difference in pre test values of the 30M Sprint Test score between Group A & Group B (*P > 0.05).*

*This table shows that there is a significant difference in post test values of the 30M Sprint Test score between Group A & Group B (**P ≤ 0.05).*

Both the group shows significant decrease in the posttest means but (GROUP-B) which has the greater mean difference is more effective than (GROUP-A). Hence the null hypothesis is rejected.

Table – 3: Comparison of vertical jump test and 30m sprint test between pre test and post test within group - a

GROUP - A	PRE TEST		POST TEST		t-TEST	SIGNIFICANCE
	MEAN	SD	MEAN	SD		
VERTICAL JUMP TEST	57.80	5.93	61.00	6.00	18.33	0.0001
30M SPRINT TEST	4.27	0.12	4.19	0.13	14.11	0.0001

The above table reveals the Mean, Standard Deviation (S.D), t-test and p- value of the Vertical Jump Test and 30M Sprint Test scores between Pre Test and Post Test within Group A.

There is a statistically highly significant difference between the pre test and post test values of Vertical Jump Test and 30M Sprint Test scores within Group - A. Hence the null hypothesis is rejected.

Table 4: Comparison of vertical jump test and 30m sprint test between pre test and post test within group – b.

GROUP - B	PRE TEST		POST TEST		t-TEST	SIGNIFICANCE
	MEAN	SD	MEAN	SD		
VERTICAL JUMP TEST	59.07	6.75	67.47	7.34	3.74	0.0001
30M SPRINT TEST	4.29	0.10	4.10	0.08	35.25	0.0001

The above table reveals the Mean, Standard Deviation (S.D), t-test and p- value of the Vertical Jump Test and 30M Sprint Test scores between Pre Test and Post Test within Group B.

There is a statistically highly significant difference between the pre test and post test values of Vertical Jump Test and 30M Sprint Test scores within Group - B. Hence the null hypothesis is rejected.

DISCUSSION

Sprint training plays a vital role in improving an athlete’s explosive power and short sprint performance. Explosive power, which refers to the ability to produce maximum force in a short period of time, is essential for sprinters, especially during the acceleration phase. This study aimed to compare the effectiveness of heavy sled load sprint training and plyometric training on improving explosive power and short sprint performance among sprinters. The following discussion explains the findings, underlying mechanisms, and limitations of the study.

Heavy sled load sprint training is widely used to improve sprint acceleration by increasing horizontal force production. When an athlete performs sprinting with added resistance, such as sled dragging or pulling, greater muscular effort is required. This leads to improved neuromuscular activation, increased recruitment of motor units, and enhanced force generation. The exercises used in this study, such as forward sled drag, backward sled drag, and resisted sprint with sled, closely mimic the sprinting movement pattern, thereby improving sport-specific performance. These adaptations are particularly beneficial during the initial acceleration phase of sprinting.

On the other hand, plyometric training focuses on the stretch-shortening cycle (SSC), which involves a rapid transition from muscle lengthening (eccentric phase) to muscle shortening (concentric phase). Exercises such as bounding, split jumps, and power skips enhance the ability of muscles to store and release elastic energy efficiently. This results in improved explosive power, coordination, and reactive strength. Plyometric training also enhances neuromuscular efficiency and improves the speed of muscle contraction, which are important factors for sprint performance.

The results of this study showed that both heavy sled load training and plyometric training produced significant improvements in explosive power and 30m sprint performance. However, the plyometric training group demonstrated greater improvement compared to the heavy sled training group. This may be due to the ability of plyometric exercises to directly improve the stretch- shortening cycle efficiency, which plays a major role in sprinting and jumping activities. The increase in vertical jump performance observed in the plyometric group indicates enhanced lower limb power and muscle elasticity.

Similarly, improvements in 30m sprint performance were observed in both groups, with greater improvement in the plyometric group. This suggests that plyometric training may be more effective in improving sprint speed over short distances. The rapid force production and improved coordination developed through plyometric exercises contribute to better stride efficiency and acceleration.

The findings of this study are supported by previous research, which indicates that both resisted sprint training and plyometric training are effective in improving sprint performance. However, plyometric training may provide greater benefits in terms of explosive power due to its direct involvement of the stretch-shortening cycle.

Despite these positive findings, this study has certain limitations. The duration of the training program was only four weeks, which may not be sufficient to observe long-term adaptations. The sample size was limited, and only male sprinters were included, which restricts the generalization of the results. Additionally, external factors such as nutrition, recovery, and individual training background were not controlled.

In conclusion, both heavy sled load sprint training and plyometric training are effective methods for improving explosive power and short sprint performance among sprinters. However, plyometric training appears to be more effective in enhancing these performance variables over a short training period. Therefore, incorporating plyometric exercises into regular training programs may provide greater benefits for sprinters in improving performance.

CONCLUSION

This study concludes that both heavy sled load sprint training and plyometric training are effective in improving explosive power and short sprint performance among sprinters. However, plyometric training shows greater improvement in performance when compared to heavy sled load training. It improves power, speed, co-ordination and sprint ability.

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