Article Title:

Sled Resisted Sprint Training: A Review of the Literature

Author:

Brad Immermann BAppSc (Chiro) BHSc

Research Location:

Edith Cowan University, Joondalup, Western Australia

Institution:

Edith Cowan University, Joondalup, Western Australia

Author Correspondence:

Brad Immermann
15b Pearce St,
Caulfield South, Vic, 3162
Phone: (61) 414 562 290
Email: bradimmermann@gmail.com

Resisted sled training, with loads of up to 30% of body mass, appears to be an appropriate training intervention regarding improvement of acceleration and transitional phase sprint performance.

Abstract

Sled Resisted Sprint Training: A Review of the Literature

Background: Sled-resisted sprint training (RST) has emerged as a common intervention strategy for enhancing sprint performance, yet the optimal implementation strategies and expected outcomes remain debated in the literature.

Objective: To systematically review and evaluate the effectiveness of sled-based training interventions on sprint performance across different populations and loading protocols. Methods: Twenty-one studies involving athletic and active populations were analyzed for training effects on sprint performance, focusing on acceleration and maximal velocity phases. Studies examining various sled loads and comparing RST with unresisted sprint training (UST) were included.

Results: Heavier sled loads (20-30% of body mass) demonstrated greater effectiveness in improving early acceleration ability, while lighter loads (5-12.5% body mass) were more beneficial for maximal velocity development. Combined RST and UST programs produced superior results compared to UST alone (-2.43 ± 0.67% vs -1.15 ± 0.72% improvement over 30m). RST showed stronger evidence supporting acceleration development rather than maximal velocity training. Phase-specific improvements were observed, with distinct outcomes in acceleration versus maximal velocity phases.

Conclusions: RST is an effective targeted intervention, particularly beneficial for athletes in sports requiring explosive acceleration over short distances (10-20m). Training protocols should be tailored to specific objectives, with load selection based on whether acceleration or maximal velocity enhancement is the primary goal. While both RST and UST demonstrate performance benefits, practitioners should align training modality and load with specific performance goals and athletic requirements.

Keywords

Sprint, resisted, sled, performance, acceleration.

Introduction

There is a large amount of evidence indicating the correlation between sprint performance and various measures of strength (3) and power (13, 23). One alternative to traditional strength and power training for enhanced sprint performance is the use of sled based training. This literature review aims to provide athletes and coaches with valuable information regarding the implementation of resisted sprint training (RST) with the use of a sled based system, and the outcomes an individual would expect to achieve with the incorporation of sled towing into their workout. The aim is to assess the merit of sled based training in different aspects of the sprint phases such as early acceleration (0-10m), transition and maximal velocity phases (36-100m)(7), as well as add comparison to both unloaded sprint training (UST) and a variety of loads.

Methods

This literature review was conducted using Google Scholar and SPORTDiscus. The following keywords were used in the literature search; sled AND sprint AND performance, resisted AND sprint, sled AND performance providing 1550 search results. Results were further limited to only journal articles and studies containing subjects that had been competing in a league at the time of the study, or who were considered to be professional or semi-professional athletes, with 21 articles being utilised for the purpose of this review. The selection criteria for studies included were the use of a sled device and the inclusion of a comparison group of either differing sled weights or unweighted trials.

Discussion

Resisted Sprint Training or Unresisted Sprint Training

Overall sprint performance improvement in athletes can come from either improvement in acceleration ability or an increase in maximal sprint velocity (8). Five studies were analysed for overall sprint performance, which included studies testing both velocity and acceleration over a range of 30-50m. The first study major study utilised in this review, using a 7.5% reduction in maximal velocity to gauge weight, found that the RST group was able to improve their velocity in the transition phase. The UST group improved maximal velocity (1.3% in the RST group compared to 1.8% in the UST group), however the difference in overall sprint performance was negligible when comparing the two groups over a 50m distance (1). Another study further supported this, finding “no training effect” existed over a 30m distance (10). In this study, each training intervention, be it RST or UST, showed improvement in different phases of the sprint, however states no overall benefit as the net result of the training interventions was comparable. Another study confirmed the above mentioned points in a group of untrained (but physically active) females, finding there to be very little difference in overall sprint performance improvement, again finding that any significant change overall was limited (17). In one of the observed papers, the results were in fact contrary to common hypothesis, finding that UST may even be superior to RST for improving sprint performance, seen in their trials with athletes pulling 10% body mass (BM) (5). Between groups, improvement was made in either velocity or the transitional phase depending on the subject group, but never both (17). One study included a combination of UST and RST as well as an UST only group, finding that sprint performance improved for both groups, but the mixed group produced a more significant change compared to the UST group (-2.43 □ 0.67% and -1.15 □ 0.72% respectively) over a 30m distance (22).

Weight Of Sled

The weight of a sled is measured throughout the literature as the weight of the sled plus the load added to the sled itself. Most studies appear to use a percentage of body mass as a means to assess appropriate sled loading, however these forms of measurement present their own difficulties to be discussed. Eight studies examined appear to provide valuable information on the use of varying sled weights and their impact on sprint performance. One such study proposes the use of the regression equation: % body mass = (20.8674 3 % velocity) + 87.99, initially calculated during a study of national level athletes on a synthetic running track with spikes (2). When the desired training weight prescribed is low, some papers found difficulty in using this equation as the minimum weight of the sled is 4.0-4.5kgs (1). They do offer a slightly less accurate solution of lessened resistance through the use of weighted vests and parachute, however this was less than desirable (1). It is further stated that different loads should be used depending on the training goal, be it the improvement in the acceleration phase (0-30m) requiring heavier loads, or improvement in the maximum velocity phase (30-60m) requiring slightly reduced loads. Further studies aim to offer a solution to the question of optimal sled loading using 3 different loads to compare acceleration and maximal velocity outcomes (4). Loads were calculated based off % body mass, cited as high (20%), medium (12.5%) and low (5%) load (4).

The authors concluded that different loads should be used for various goals which draw similar conclusions to previously mentioned studies, with a different approach to load test prescription (1). One paper only observed changes in the first 5m of the sprint but determined that loads of 30% BM are more effective than lighter loads of 10%, consistent with another paper of the same author suggesting a 5.7 □ 5.7% improvement over 5m and 5.0 □ 3.5% improvement over 10m compared to an equivalent lighter load of 10% BM only seeing a time reduction of 3.0 □ 3.5% (11, 12), however in their second study the weight was adjusted to ensure consistency by modifying the sled weight (11). The aim was to reduce maximal velocity to 70% and 90% of un-resisted maximal velocity in the heavy and light group respectively (12). These modifications were incorporated purposefully, to address concerns illustrated in earlier research (2) questioning the potential negative effects of highly loaded RST on sprint kinematics and performance in the early acceleration phase. It was suggested that the use of a regression equation slightly different to the aforementioned equation be used (15,2), however the authors noted that simply using 12.6% BW instead of a complex equation would result in a similar figure and be easier to apply practically without significant, potentially detrimental change in sprint kinematics, which were suggested to be detrimental and highly possible under excess loads in other studies (18). One paper found contrary results, concluding that the use of 12.4 □ 0.02, similar to the loading found in the other papers (14), does not achieve superior acceleration results compared to unloaded sprint training (16), however notes that current testing load recommendations used throughout multiple studies for the 0-30m trial may have been “too light” and therefore inappropriate. They further suggest the need of a different measurement for women who may have a slightly altered optimal load relative to body mass when compared to males (16). Various papers note that weight calculated off percentage of body mass is flawed as it does not account for individual variances in muscle mass, strength and power and suggest improvements in measurements to be made off pre-testing scores such as isokinetic assessments (16, 19). These variants may lead to athletes of the same BM with differing strength profiles, towing the same load, experiencing varying levels of training intensity and input resulting in different effects on maximal velocity percentage.

Figure 1 Summary of results for sled based intervention with varying sled weights.

Study	Study Duration	Sled Load	Testing Distance	Sprint Effect	% Change
Alcaraz (2014)	3wk	7.5% ↓ MV	50m	↑ Acc.	2.36%
Bachero-Mena & Gonzalez-Badillo (2014)	7wk	5% BM	40m	↑ MV	NA
		12.5% BM		↑MV	NA
		20% BM		↑↑ Acc.	NA
Clark et al. (2010)	7wk	10% BM	54.9m	Nil	0.03%
Kawamori et al. (2014)	8wk	30% ↓ MV	10m	↑↑ Acc.	NA
		10% ↓ MV		↑ Acc.	NA
Luteberget et al. (2014)	10wk	12.4% BM 12.4% BM	10m 30m	Nil ↑ Acc	0.08% 0.93%
Makaruk et al. (2013)	9wk	7.5% BM	20m	↑ Acc.	2.5%
Sprinks et al. (2007)	8wk	10% ↓ MV	15m	↑↑ Acc.	NA
West et al.	6wk	12.6% BM 12.6% BM	10m 30m	↑MV ↑MV	2.43% 2.46%
Zafeiridis et al. (2005)	8wk	5kg	50m	↑ Acc.	1.05%

↓ = Reduction; ↑ = Improvement; ↑↑ = Significant Improvement BM = Body Mass; MV = Maximal Velocity; Acc = Acceleration

Maximal Velocity and Acceleration

It was found the acceleration/transition phase of sprinting (15-30m) improves significantly in national level track and field athletes with RST training whereas UST showed to improve the maximal velocity phase of the sprint by 1.8% compared to that of RST group, with a 1.3% improvement (1). These results were consistent other studies who found that UST group yielded superior results, regarding maximal velocity, compared to the RST group towing 10% BM by achieving 1.97% improvement in time (5). In this study the weighted group revealed no significant change, consistent with another paper that also came to the same conclusions, testing both resisted to 90% of maximal velocity groups and UST groups (17). To add further support to these findings, similar results were found when testing larger distances up to 50m (24). In this study, it was shown that the RST group achieves favourable results compared to that of the UST group over the acceleration phases of 0-10m and 10-20m, where the UST group achieved no statistically significant change. Conversely, the UST group tested better regarding maximal velocity in the 20-40m, 40-50m and 20-50m sections with no significant change being observed in the RST group. Other studies available show contrasting results, with one finding traditional sprint training to be more effective than resisted sprint training over a 30m sprint test in a team of semi-professional handball players (16). Although RS training creates performance enhancements in the acceleration phase of sprinting, it was observed to be no more effective than UST training when small loads of approximately 10% of body mass was used (20). This was due to the authors apprehension that acceleration kinematics could be adversely affected at a resistance of above 10% of body mass (15), however other studies have found that resistance of up to 30% BM may be used without interfering with stride length and stride frequency (19). Various loads could further be used to achieve different outcomes. Other studies found that loads of 20% BM resulted in time reduction for the acceleration phase, however lower loads of 5-12.5% BM were more effective in achieving results in the maximal velocity phase of sprinting (4). Further studies support previously mentioned studies, finding that RST significantly improves acceleration ability in professional, semi-professional athletes or athletes currently participating in field sports when loads equivalent to 12.6-13% BM were used based off the recommendations using the calculation load = ([body mass x %body mass] - sled weight), specifically in the initial 5 to 10m take off phase (10, 14). Further support for the improvement in acceleration during the initial take off phase with sled towing was found when comparing heavy (30% BM) and light (10% BM) sled-towing to un-resisted loading due to an increase in net horizontal impulse, found specifically in the 30% BM group (12). Whether these findings can be applied to produce chronic adaptation, the author states, remains unknown. Others state that RST is more beneficial to maximum velocity in sprinting than UST, finding that over 36.6m track, the RST group achieved a higher mean velocity than the UST group in the final 13.7m (21). The study seems to be the only one available suggesting RST to be superior over UST regarding recommendations for peak maximal velocity training (21).

Limitations

Only one study examined the overall sprint performance changes in a distance of 50m which leaves room for further examination. Surface friction, angle of pull and sprint kinematic variables were not included as strong considerations as they were outside the scope of this review. Sprint kinematics are an important consideration to be made as studies have found that different resistances and modes of resistance vary kinematics in a way that may provide further insight into sprint performance gains or hindrance (6).

Conclusion

Review of the research suggests both RST and UST allow for improvement in sprint performance with variance in the phase where the outcome is achieved. RST appears to produce better outcomes than UST in the initial acceleration phase while UST produces greater outcomes in the maximal velocity phase. Weights of approximately 12.6% BM will provide acceleration and velocity benefit to athletes, however heavier weights (up to 30%) appear to have more support for appropriate application, particularly in initial acceleration phase training. Heavily loaded sleds may provide large benefit to athletes requiring short bouts of explosive acceleration, in sports such as rugby where 10-20m sprints are the predominating bout length (9). For coaches, the designated load should be based upon the goals of the training, be it acceleration or maximal velocity.

Further Research

There appears to be only one study investigating the effects of sled training on distances greater than 30m, and a lack of studies examining chronic loading of greater than eight weeks' duration. There also appears to be a lack of research comparing UST and heavily loaded RST. No studies currently examine the effects of concurrent resistance training (such as plyometric or strength specific training) and RST. This would be beneficial as it would most likely improve practical application outcomes, as athletes will likely use these tools are part of their regular training program.

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