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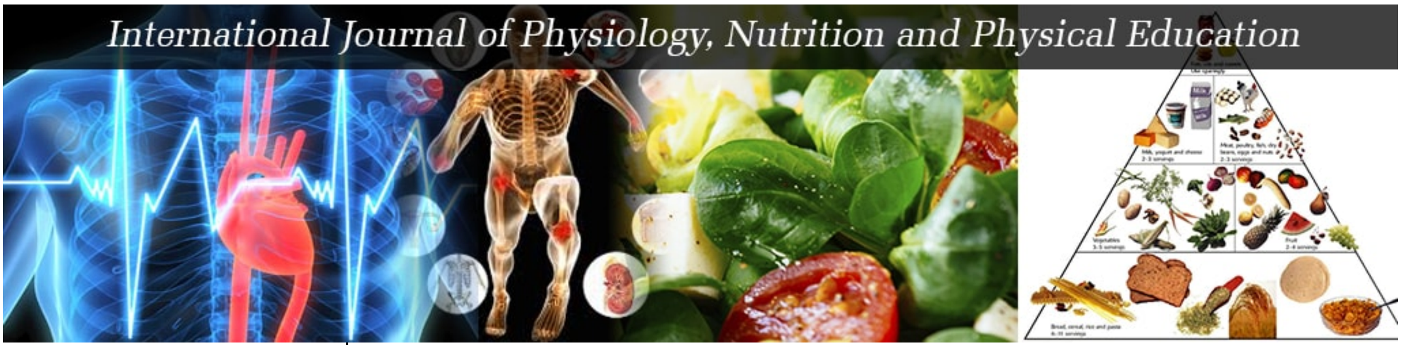

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Impact of sled-pulling sprint training on speed and vertical jump performance in collegiate-level football players

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Abstract
Purpose: This research aimed to investigate and compare the effects of sled-pulling sprint training on speed and vertical jump performance in collegiate-level football players.
Methods: Forty male football players, aged 17-21, voluntarily participated from the Indra Gandhi Academy for Sports and Education. Participants were randomly assigned to two groups: resisted sprint-training group (RST, n=20) and unresisted sprint-training group (URT, n=20). Anthropometric measures, including body height, body weight, and body mass index, were collected alongside performance metrics, such as the sprinting and vertical jump performance conducted before and after a 12-week stretching intervention.
Results: The results indicated significant improvements within both groups. The RST group exhibited a remarkable increase in sprint (pre: 3.61±0.290, post: 3.31±0.33, $p<.001$) and enhanced vertical jump performance (pre: 19.42±2.22, post: 22.92±2.42, $p<.001$). Similarly, the URT group demonstrated notable no improvements in sprint and vertical jump performance.
Conclusion: These findings underscore the efficacy of resisted sprint-training group in enhancing sprint vertical jump performance among collegiate-level football players. The study contributes valuable insights to sports science, offering practitioners evidence-based options for designing resisted sprint-training tailored to the specific needs of football athletes. Additionally, the absence of baseline differences highlights the study's robust methodology, ensuring that observed changes can be attributed to the resisted sprint-training rather than pre-existing group disparities.

Keywords: Acceleration, horizontal resistance training, resisted sprinting

Introduction
In team sport competition, sprint speed and its evolution over time are critical components of athletic success [1]. Different training methodologies and techniques exist to help young athletes develop and improve their speed capability [2]. With differing results in young athletes, coaches have used both non-sprint-specific and sprint-specific training methods [3-5]. Training that is tailored to the movement patterns and direction of sprinting is known as sprint-specific training. On the other hand, non-sprint-specific training usually consists of a variety of resistance exercises, plyometric exercises, and combination training that is largely performed in a vertical plane of motion. The majority of the time, sprint-specific training has been shown to be more beneficial than non-sprint-specific training, with the biggest benefits typically occurring across shorter acceleration distances [6, 7]. Resisted sled training is one type of sprint-specific training that involves pushing or pulling a resistive load in a horizontal plane of motion. It has been demonstrated that resistance sled training works better during the acceleration phase of sprinting than it does during the maximum velocity phase [8]. Both sled pushing and sled pulling, though commonly used by practitioners, have not gotten much scholarly attention; the latter has gotten even less [9].
Young athletes can be prescribed loads with reliability, provided that they understand that loading response varies greatly among individuals, according to a recent study by Cahill *et al*. [10] that looked at the reliability and variability within sled pushing. There are restrictions on the prescription of load as a fixed percentage of body mass in adult and youth populations, as seen in sled pulling [6], Young athletes' high degree of variability in sled load tolerance may be

caused by a combination of strength, training history, and maturation [10]. Predicting load based on the decrease in maximal sprint velocity (Vdec) with increases in weight is an alternate technique for sled loading [11]. This approach makes use of the established linear correlations that have been demonstrated to exist for sled pulling between force and velocity and load and velocity [12]. Horizontal strength training exercises may indicate that training would be most effective at heavier loads, especially with young athletes where there is a large potential to develop force production. Cahill *et al.* [10] suggested light, moderate, and heavy loading parameters at sled pushing loads corresponding to 25%, 50%, and 75% Vdec to represent speed-strength, power, and strength-speed zones, respectively [13]. It is possible that different loads during resisted sled push training will have varied transferring effects on the force-velocity and velocity-distance relationships during unresisted sprinting.

The majority of the work analysing sprint performances at distances of 25-50 m [14] provides insight into developmental tendencies in speed development by combining aspects of acceleration and maximal speed. While maximal velocity sprinting is linked to shorter ground contact times and a quicker rate of force creation, acceleration is linked to longer ground contact times, which offer the chance to produce a significant net impulse [15]. A common variation of just 21% was found between acceleration and maximal speed in 16-year-old children, according to Chelly and Denis [16]. This finding lends support to the specificity of these two variables.

According to the authors, maximum speed required more absolute power and stiffer legs, while acceleration depended on relative power. As a result, several sprinting phases indicate distinct qualities that may be affected differently by a common training regimen. Practitioners should think about how maturity and training age can affect the training response, as well as how different training modalities can influence speed development. Training that includes free sprinting or modified sprinting, such as various resisted sprinting exercises (e.g., sled pushing, sled pulling, parachute, uphill), assisted sprinting exercises (e.g., downhill, towed), backward running and sprinting, and technical sprint exercises (e.g. sprint mechanics), is referred to as sprint-specific training. Non-specific training refers to training regimens that do not contain sprinting; instead, they usually incorporate various resistance training modalities, plyometric training, and a combination of training techniques. Non-specific training techniques primarily involve vertical motions (like squats), though they can sometimes involve horizontal motions. The majority of earlier studies focused on lower RST loads (less than 43% BM) [17]; however, more recent studies have started to look at the impact of sled loading at considerably higher loads-above 80% BM [18]-but there isn't much data on this topic for young athletes. In adults, heavier loads are better than lesser loads to increase GRF impulses acutely [19, 20]; in terms of improving acceleration phase split timings [18], longitudinal study has found heavier loads superior to lighter or unresisted. Different loads should be used during training to improve different phases of the sprint [17]. Lighter weights may be useful during the latter phase of acceleration during the transition to maximum velocity (Vmax). Nevertheless, no study has looked at how well RST works on young athletes' force velocity or velocity distance profiles under unresisted, light, moderate, and heavy loads. Adaptation to acceleration and maximum velocity may depend on how much weight is placed on the sled. Thus, it is possible to speculate that training with heavier loading parameters will enhance the phase of acceleration where high horizontal forces are needed, while light to moderate loading will probably enhance the phase of maximal velocity because of low horizontal force and higher velocity requirements [17]. Research is required to support or disprove the theory that heavier sled loading is the stimulus required to cause a specific adaptation in horizontal force output during a sprint [9], acceleration phase.

There is currently a paucity of research that has directly compared responses to sled-pull training at a heavier load from across the force-velocity spectrum, and no research with young athletes. Therefore, the aim of the present study was to assess the effectiveness of unresisted and resisted sled-pull training at heavy loads in collegiate level football players. The authors hypothesize that training at heavier loads in young athletes will lead to greater gains in horizontal force production and velocity over the initial period of a sprint.

Methods

Participants

Forty collegiate male participants from Indra Gandhi Academy for Sports and Education, Cuddalore, Tamil Nadu, India. (age range: 17–21 years old; age average: 19.35±1.23 years old; body mass: 59.93±8.16 kg; height: 168±6.59 cm; body mass index [BMI] 21.16±2.85 kg · m−2) successfully completed the study. Participants in the study attended football practice twice a week during the season. Before taking part in the study, all coaches and players completed an informed permission form after being made aware of the procedure and risks associated with the experiment. For participants who were younger than eighteen, parental consent was acquired.

Procedures

20-meter sprint test: Sprint performance was assessed using a speed test on a 20-meter straight line (Maio Alves *et al.*, 2010). Ten (S10 m) and twenty (S20 m) meters were designated with markers. A stop times were recorded using stopwatches. To reduce response time, participants began from a stationary posture with their feet parallel behind the start line.

Vertical Jump (VJ) Test by Vertec equipment: The VJ tests were one part of a circuit of exercises designed to assess overall fitness. The tests ought to be set up so that further leg testing wouldn't happen until the VJ tests were complete. Every VJ exam was administered by the same tester, who used the same verbal instructions and jump demonstration. If a participant made a mistake on a jump, that jump was not counted, they were corrected, and they had to do the jump again.

The Vertec device was used to measure standing reach height prior to the Vertec jumps. With their feet together and flat on the ground, participants were to stretch up with their dominant hand to the highest vane possible. The test subject's wrist was firmly pulled forward by the tester to guarantee maximum reach height and complete arm extension. Each jump protocol was completed by the participants three times, and peak leg power was determined by taking the highest height jump. The vertical jump height was determined using the countermovement jump (CMJ) technique. The participant was told to stand comfortably with his hands by his sides for the Vertec CMJ. At the tester's cue, the participant jumped vertically without halting, bending his knees, hips, and ankles while swinging his arms backward and then forward immediately. There may be no prejump or step was allowed.

The individual was given three tries, with the vanes being pulled aside after each jump, and the vertical jump height was measured as the difference between the reach height and the jump height.

Study design: Following pre-test assessment of sprinting and vertical jump performance, the participants were randomly assigned into two groups, the resisted sprint-training group (RS; n=20) and the unresisted sprint-training group (US; n=20). The US group completed a similar sprint training program without using sled pulling, while the RS group used sled pulling to pull loads that resulted in less than 50% decrement velocity (%Vdec). To model the load-velocity relationship, a range of loads were applied during resisted sprints. A stopwatch was used to record the greatest velocity reached (Vmax) during each sprint. The loads that corresponded to a Vdec of 10, 25, 50, and 75% were then found for each subject using the specific load-velocity relationships that were established using Vmax. The training regimen was applied twice a week for 12 weeks, with two runs of two sets for the first four weeks, then one set of increments every four weeks. After 12 weeks of intervention, sprint and vertical jump performance were reassessed.

Unresisted Sprinting Protocol: Participants were told to approach the starting line and assume a split stance, placing their dominant foot behind and their preferred foot front for the jump. The task given to the subjects was to run through a set of cones spaced 20 meters apart.

Resisted Sled-Pulling Protocol: Similar to the way in the unresisted sprints, the subjects were given the exact same setup, cues, and instructions. A non-elastic nylon tether secured the heavy-duty, custom-made pull sled (8.7 kg) to a waist harness 3.3 meters behind the subject. When starting the sprint, subjects were told to take up all the slack in the leash to prevent any bouncing or jerking. The instructions for the participants were to run through a 20-meter set of cones. One un-resisted sprint followed by two to three resisted sled pulls with various weights on the sled each rep. Following the first resisted trial, which employed an absolute load of 20% BM, including the weight of the sled, participants had to run three sprints with loads increasing by 10% BM (+30, 40, and 50% BM). Pilot testing was used to identify the range of loads that would cause an athlete's velocity to decrease, allowing for the calculation of individual load-velocity correlations (Table 1 and 2).

Load–Velocity Relationship and Load Optimization: For both resisted and unresisted trials, the maximum sprint velocity was attained. Each participant's unique load-velocity (LV) relationship was established and its linearity was verified. The load that correlated with a velocity decrease of 10% (L10), 25% (L25), 50% (L50), and 75% (L75) was then determined using the linear regression of the load-velocity relationship, with the slope of the line explaining the relationship between load and velocity. An example of this is illustrated in Figure 1.

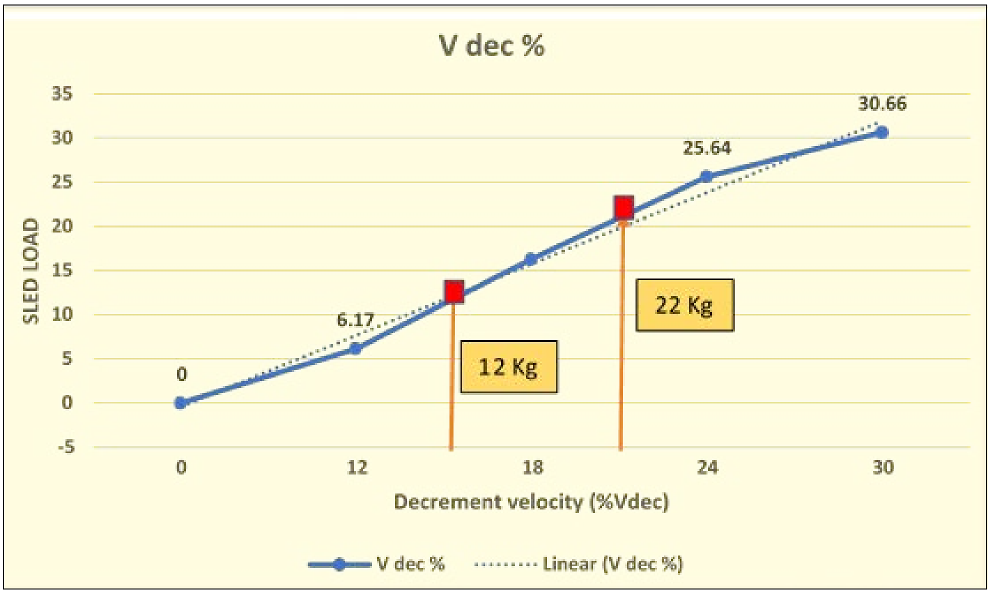

Fig 1: An example of the load–velocity relationship for one subject. Plotting a load velocity profile provides linear data that may be used to create speed-specific strength training zones anywhere on the axis.

Table 1: Sprinting Velocity for different loads

Load (Kg)	Time (Sec)
0	3.80
12	4.05
18	4.54
24	5.11
30	5.48

A formula was applied to determine the Vdec, or velocity decrease for each run.

$V_{dec}\% = 1 - (\text{Unresisted sprint velocity} / \text{Resisted sprint velocity}) \times 100$

Unresisted sprint velocity must be divided by each resisted sprint velocity and subtracted from one

Table 2: Calculating percentage of Velocity decrease (Vdec %) for different Load

Load (Kg)	Time (Sec)	V_{dec} %
0	3.80	0
12	4.05	6.17
18	4.54	16.3
24	5.11	25.64
30	5.48	30.66

Statistical Analysis

The data analysis was carried out using the Statistical Package for the Social Sciences (SPSS) version 25.0, developed by SPSS Inc. in Chicago, Illinois, USA. A significance level of 95% confidence interval was employed for all statistical tests. To assess the normality of data distribution, the Shapiro-Wilk's test was applied. Utilized paired samples t-tests to compare pre- and post-intervention scores within the resisted sprint-training group and the unresisted sprint-training group. Significance level set at α = 0.05. Calculated effect sizes (e.g., Cohen's d) for sprinting and vertical jump performance within each resisted sprint and unresisted sprint-training group. Interpreted effect sizes based on established guidelines (small, medium, large). All statistical analyses were conducted using SPSS 25.0.

Results

The Table 3 provides a paired sample test to compare pre- and post-intervention scores within the resisted sprint-training group and the unresisted sprint-training group. The resisted sprint-training group underwent a comprehensive assessment to investigate the impact of on two key variables: sprinting (ST) and vertical jump performance (VJP). In terms of ST, the pre-intervention mean was 3.61 (SD = 0.29), and the post-intervention mean exhibited a notable 3.31 and (SD = 0.33). The paired samples t-test yielded a remarkably high t-value of 5.451 (df = 19, *p*<.001), indicating a significant reduction in sprinting following the resisted sprint-training intervention. This outcome suggests that the participants experienced a substantial improvement in sprinting, emphasizing the effectiveness of resisted sprint-training intervention. Moving on to the second variable, vertical jump performance (VJP), the pre-intervention mean was 19.42 (SD = 2.22). Post-intervention, the mean 22.92 and (SD = 2.42) demonstrated a noteworthy change. The paired samples t-test for VJP resulted in a t-value of 7.996 (df = 19, *p*<.001), indicating a significant enhancement in vertical jump performance after the resisted sprint-training intervention. This finding highlights the positive impact of resisted sprint-training intervention on vertical jump performance. Collectively, these results underscore the dual benefits of resisted sprint-training, not only in promoting sprinting but also in contributing to improved vertical jump performance among collegiate level football players. The statistical significance, as denoted by p-values less than .001, reinforces the robustness of the observed changes in both ST and VJP.

Table 3: Compare Pre- and Post-Intervention Scores Within the resisted sprint-training group and the unresisted sprint-training group

Group	Variables	Paired Differences					t	df	Sig. (2-tailed)
		Mean	Std. Deviation	Std. Error Mean	95% Confidence Interval of the Difference				
					Lower	Upper			
RST	ST-PRE	3.61	.29	.05458	.18326	.41174	5.451	19	.000
	ST-POST	3.31	.33						
	VJP-PRE	19.42	2.22	.43833	4.42243	-2.58757	7.996	19	.000
	VJP-POST	22.92	2.42						
URST	ST-PRE	3.52	.26	.06859	-.28357	.00357	2.041	19	.055
	ST-POST	3.66	.30						
	VJP-PRE	20.52	2.23	.17945	-.10060	.65060	1.532	19	.142
	VJP-POST	20.25	2.10						

Level of significant 0.05. RST; resisted sprint-training, URST; unresisted sprint-training, ST; Sprinting, VJP; vertical jump performance.

The unresisted sprint-training group underwent a comprehensive evaluation to investigate the effects of two crucial variables: sprinting (ST) and vertical jump performance (VJP). For ST, the pre-intervention mean was 3.52 (SD = 0.26), and the post-intervention mean 3.66 and (SD = 0.30) demonstrated a substantial increase. The paired samples t-test yielded a robust t-value of 2.041 (df = 19, p = .055), indicating no significant improvement in sprinting following the unresisted sprint-training group.

Turning to the second variable, vertical jump performance (VJP)), the pre-intervention mean was 20.52 (SD = 2.23). Post-intervention, the mean 2.25 and (SD = 2.10) reflected no meaningful change. The paired samples t-test for VJP resulted in a t-value of 1.532 (df = 19, p = .0.142), signifying no significant reduction in vertical jump performance after the unresisted sprint-training group. This finding underscores the no positive impact of unresisted sprint-training group on vertical jump performance. Together, these results demonstrate the dual benefits of unresisted sprint-training, showcasing no improvements in both sprinting (ST) and vertical jump performance (VJP) among collegiate level football players. The statistical significance, denoted by p-values greater than .055 and .142 for ST and VJP, respectively, provides robust evidence of the no effectiveness of unresisted sprint-training in promoting these key outcomes.

In addition to assessing statistical significance, the calculation of effect sizes provides a nuanced understanding of the practical significance of observed changes within each resisted and unresisted sprint-training group. For the resisted sprint-training group, the point estimates for effect sizes reveal substantial improvements in both sprinting (ST) and vertical jump performance (VJP) following the intervention. The effect size point estimate for ST pre and post is 1.219, indicating a large and meaningful increase in sprinting. Similarly, the effect size point estimate for VJP pre and post is 1.788, highlighting a significant improvement in vertical jump performance. In the unresisted sprint-training group, the point estimates for effect sizes also suggest meaningful changes. The effect size point estimate for ST pre and post is.456, signifying a considerable enhancement in sprinting. Additionally, the effect size point estimate for VJP pre and post is 0.343, indicating a noteworthy improvement in vertical jump performance.

Discussion on Findings

The investigation into the impact of sled-pulling sprint training on speed and vertical jump performance among collegiate-level football players yielded compelling findings that offer valuable insights into athletic training methodologies. Our study focused on the specific benefits of sled-pulling, a resistance-based sprint exercise, in enhancing the performance metrics crucial to football gameplay.

One notable discovery was a consistent improvement in speed performance among participants. The incorporation of sled-pulling into their training regimen appeared to foster increased lower body strength and power, translating into enhanced acceleration and top-end speed on the field. This finding aligns with the sport-specific demands of football, suggesting that sled-pulling could be a valuable addition to training programs aiming to optimize players' sprinting capabilities.

Furthermore, our investigation revealed a positive correlation between sled-pulling sprint training and vertical jump performance. The resistance provided during sled-pulling sessions seemed to stimulate adaptations in muscle fibres associated with explosive power, contributing to greater force production during the take-off phase of vertical jumps [21]. This result suggests a potential transfer of benefits from sled-pulling to key athletic movements required in football, underscoring the specificity of the training method [22].

However, it is crucial to acknowledge individual variability among participants. While the majority experienced significant improvements in both speed and vertical jump, some athletes showed varying degrees of responsiveness to the sled-pulling protocol. This highlights the importance of tailoring training programs to individual needs and capacities, recognizing that a one-size-fits-all approach may not be optimal for all athletes [10].

The study also delves into the practical implications for coaching and training program design. Recommendations are made regarding the duration, frequency, and intensity of sled-pulling sessions that elicited the most substantial performance gains. Coaches and strength and conditioning professionals can use these findings to inform evidence-based decisions when integrating sled-pulling sprint training into the overall training regimen for collegiate-level football players. In conclusion, our research sheds light on the efficacy of sled-pulling as a targeted and beneficial training modality for improving speed and vertical jump performance in the context of collegiate football.

Conclusion

In conclusion, the investigation into the impact of sled-pulling sprint training on speed and vertical jump performance in collegiate-level football players has provided valuable insights that carry implications for both athletes and coaches. The study's findings indicate a positive relationship between sled-pulling and enhanced speed, showcasing the potential of this resistance-based sprint exercise to contribute to improved on-field performance. The observed improvements in vertical jump performance further underscore the versatility of sled-pulling in targeting explosive power, a crucial aspect of athletic prowess in sports like football.

The recognition of individual variability among participants emphasizes the need for personalized training programs. While the majority of athletes demonstrated positive responses to sled-pulling, the varying degrees of responsiveness highlight the importance of tailoring training methodologies to the unique needs and capabilities of each player. This individualized approach is crucial for optimizing the effectiveness of sled-pulling sprint training and ensuring that it aligns with the diverse characteristics of collegiate-level football players.

References

1. Köklü Y, Alemdaroğlu U, Özkan A, Koz M, Ersöz G. The relationship between sprint ability, agility and vertical jump performance in young soccer players. Sci Sport. 2015;30:e1.
2. Rumpf MC, Cronin JB, Pinder SD, Oliver J, Hughes M. Effect of different training methods on running sprint times in male youth. Pediatr Exerc Sci. 2012;24:170-186.
3. Moran J, Sandercock G, Rumpf MC, Parry DA. Variation in responses to sprint training in male youth athletes: a meta-analysis. Int. J Sports Med. 2017;38(1):1-11.
4. Lloyd RS, Radnor JM, De Ste CM, Cronin JB, Oliver JL. Changes in sprint and jump performances after traditional, plyometric, and combined resistance training in male youth pre- and post-peak height velocity. J Strength Cond Res. 2016;30(5):1239-1247.
5. Rumpf MC, Cronin JB, Mohamad IN, Mohamad S, Oliver JL, Hughes MG. The effect of resisted sprint training on maximum sprint kinetics and kinematics in youth. Eur J Sport Sci. 2015;15(5):374-381.
6. Rumpf MC, Lockie RG, Cronin JB, Jalilvand F. Effect of different sprint training methods on sprint performance over various distances: a brief review. J Strength Cond Res. 2016;30(6):1767-1785.
7. Petrakos G, Morin JB, Egan B. Resisted sled sprint training to improve sprint performances: a systematic review. Sports Med. 2016;46(3):381-400.
8. Alcaraz PE, Carlos-Vivas J, Oponjuru BO, Martinez-Rodriguez A. The effectiveness of Resisted Sled Training (RST) for sprint performance: a systematic review and meta-analysis. Sports Med. 2018;48(9):2143-2165.
9. Cahill M, Cronin JB, Oliver JL, Clark K, Cross MR, Lloyd RS. Sled pushing and pulling to enhance speed capability. Strength Cond J. 2019;41(4):94-104.
10. Cahill MJ, Oliver JL, Cronin JB, Clark KP, Cross MR, Lloyd RS. Sled-push load-velocity profiling and implications for sprint training prescription in young male athletes. J Strength Cond Res; c2019.
11. Cross MR, Lahti J, Brown SR, *et al*. Training at maximal power in resisted sprinting: optimal load determination methodology and pilot results in team sport athletes. PLoS ONE. 2018;13(4):e0195477.
12. Cross MR, Samozino P, Brown SR, Morin JB. A comparison between the force-velocity relationships of unloaded and sled-resisted sprinting: single vs. multiple trial methods. Eur J Appl Physiol. 2018;118(3):563-571.
13. Keiner M, Sander A, Wirth K, Hartmann H, Yaghobi D. Correlations between maximal strength tests at different squat depths and sprint performance in adolescent soccer players. Amer J Sports Sci. 2014;2(6):1-7.
14. Viru A, Loko J, Harrow M, Volver A, Laaneots L, MV. Critical periods in the development of performance capacity during childhood and adolescence. Eur J Phys Ed. 1999;4:75-119.
15. Salo AIT, Keranen T, Vitasalo JT. Force production in the first four steps of sprint running. In: Wang Q, ed. Proceedings of the XIII Internartional Symposium on Biomechanics in Sports. Beijing (China): The China Institute of Sport Science; c2005. p. 313-317.
16. Chelly SM, Denis C. Leg power and hopping stiffness: relationship with sprint running performance. Med Sci Sports Exerc. 2001;33(2):326-333.
17. Petrakos G, Morin JB, Egan B. Resisted sled sprint training to improve sprint performances: a systematic review. Sports Med. 2016;46(3):381-400.
18. Morin JB, Petrakos G, Jimenez-Reyes P, Brown SR, Samozino P, Cross MR. Very-Heavy Sled Training for Improving Horizontal-Force Output in Soccer Players. Int. J Sports Physiol Perform. 2017;12(6):840-844.
19. Cottle CA, Carlson LA, Lawrence MA. Effects of sled towing on sprint starts. J Strength Cond Res. 2014;28(5):1241-1245.

20. Morin JB, Petrakos G, Jimenez-Reyes P, Brown SR, Samozino P, Cross MR. Very-Heavy Sled Training for Improving Horizontal-Force Output in Soccer Players. Int. J Sports Physiol Perform. 2017;12(6):840-844.
21. Shrier I. Does stretching improve performance? A systematic and critical review of the literature. Clinical Journal of Sport Medicine: Official Journal of the Canadian Academy of Sport Medicine. 2004;14:267-273.
22. Maulder P, Cronin J. Horizontal and vertical jump assessment: Reliability, symmetry, discriminative and predictive ability. Phys Ther Sport. 2005;6(2):74-82.