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THE EFFECT OF RESISTED SPRINTING ON THE PRODUCTION OF HORIZONTAL STRENGTH

Dr. Brian Serrano[1,2,*] and Dr. Jacqueline Serrano[1,3]

[1]HPI Sports Medicine and Performance, 28062 Forbes Road Unit D, Laguna Niguel, CA 92691
[2]Director of Rehabilitation and Performance
[3]Clinic Director, Owner

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****Corresponding author:* Dr. Brian Serrano***

ABSTRACT

Background: Strength is a crucial aspect of sport performance and increasing strength is an important aspect of strength and conditioning programs for athletics. Strength and conditioning professionals are constantly innovating programming methods to increase attributes that accurately translateonto the field of play. **Methods:** PubMed, CINAHL, and EBSCO were searched for systematic reviews from 2000-2020 which used resisted sprinting, either pushing or pulling and their effect on horizontal strength for include in this literature review. **Results:** Resisted sprinting results in a horizontal impulse that is sport specific to horizontal strength ($p<.05$). The most effective loading for resisted sprinting seems to be 10-30% of BW ($p<0.05$). Resisted sprinting in the form of sled pulling seems to be more sport specific because of its use of the upper extremities (CI 95%). **Conclusion:** Resisted sprinting seems to be a cost-efficient and technically effective form of increase horizontal strength which can be incorporated into training and seems to have a superior effect to vertical based training modalities.

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INTRODUCTION

Strength and Conditioning programs have evolved from primarily strength training, into well thought out, periodized programs that focus on using various modalities to enhance athletic performance (Haff, 2013; Shephard, 2009). While there a vast number of modalities that may be utilized in a sport performance program, the most common seem to be strength training, Olympic weightlifting, plyometrics, and agility exercises[2,3]. The periodization scheme used may follow a linear, non-linear, or undulating philosophy (Haff, 2013; Shephard, 2009; Baechle, 2008). Common equipment used in strength and conditioning program vary widely depending on space, setting, and financial resources (Baechle, 2008; Clark, 2008). Equipment may include squat racks, barbells, dumbbells, boxes, and objects of different weights and materials (Clark, 2008; Baechle, 2004). However, the goal of these methods and equipment is to increase sport performance. Strength and conditioning is a concept which coaches, athletes, and professionals seek to develop because it translates into higher sport performance. It has been established that many modalities increase sport performance (Baechle, 2004; Ebben, 2005). Strength training builds a strong base of athletic ability that sets the foundation for performance (Shephard, 2009; Peterson, 2004). Similarly, a moderate cardiovascular base is necessary for sport performance (Haff, 2013; Behm, 2017). Strength and Cardiovascular endurance can be built through traditional modalities such as resistance training (strength) and running intervals (cardiovascular) (Hydren, 2015; Mazoochi, 2013). Sport performance also relies on power and agility where modalities such as Olympic weightlifting, plyometric training, and quick change of direction drills may be applied (Miller et al., 2016; Chelly et al., 2010). As sports become more competitive: teams, organizations, and athletes try to find novel ways of performing better. Sprinting is seen an activity that is primarily part of Track and Field as a sport or a conditioning activity used to build anaerobic capacity (Markovic, 2007; Sloth, 2013). Research has looked into sprinting as a modality and found greater activation of type 2 muscle fibers when compared to strength training and plyometric activities (Sloth, 2013; Shalfawi, 2013). These findings are not novel, Behm et al. found sprinting to have a shorter ground reaction time when compared to plyometric activity such as bounding and box jumps (Behm et al., 2017). Similarly, Nagahara et al. (2018)

measured ground reaction forces (GRF) in sprinting and found significantly higher GRF's in sprinting as compared to vertical jumping[17]. Serrano and Serrano (2020) performed a review on Olympic weightlifting and found it to be an effective modality to increase power that could be translated into sport performance (Serrano, 2020). The dilemma anecdotally seen on the field and in the weight room is making educated guesses how to convert primarily vertically based exercises into horizontal based performance. The literature is sparse regarding guidance on which exercises to choose that best translate vertical power into horizontal performance (Randell et al., 2020). The purpose of this review article is to explore resisted sled sprinting as a modality to increase horizontal power. A best practice guideline will be made to guide sports performance and sports medicine professionals into using sled resisted sprinting to increase horizontal power performance.

MATERIALS AND METHODS

The systematic review process was directed under the Preferred Reporting items for Systematic Review and Meta-Analysis (PRISMA) guidelines and checklist[20]. The search was completed separately by two authors (BS and JS). Using keywords and Boolean operators, a literature review of the literature was performed using PubMed, CINAHL, EBSCO, and SPORTD iscus. The following terms were searched for in 'all fields': ''resisted sprint'', "sprint training", "sled sprinting", sled AND sprint, resisted AND sprint. Results were narrowed by language (English) and publication source (journal article). Further records were added based on previous reading, expertise among co-authors and other publications that were known to the authors but not found in the literature review. Inclusion criteria were as follows: (1) must have used a sled device for resisted sprint training (surface did not matter), (2) resisted sled sprints were included in training intervention between groups, (3) presence of a comparison group from the same population pool as the resisted sprint training group, and (4) study published following a peer-review process. Parachute sprint training was not counted into sled-sprint training and was excluded from our literature review.

RESULTS

Twelve papers met the inclusion criteria for this review (Petrakos et al., 2016; Alcaraz, 2018; Rumpf et al., 2016; Morin, 2017; Young, 2006; Hrysomallis, 2012; Clark, 2018; Alcaraz et al., 2014) and (Seitz, 2017; Delecluse, 1997; Zafeiridis et al., 2005; Lockie et al., 2003). For the sake of clarity, the authors defined the acceleration phase as 0–20 m and the maximal velocity phase as distances from 20-60 m from the starting position (Čoh et al., 2006; Yu et al., 2016). The two different methods of resisted sled sprinting were sled pushing and sled pulling (Petrakos, 2016; Alcaraz et al., 2018; Rumpf, 2016). Sled pushing was defined as subjects being behind the sled pushing the sled forward (Seitz, 2017). Sled pulling was defined as the sled being behind the patient while the patient pulls the sled (Morin et al., 2017; Alcaraz et al., 2014). Most studies differentiate between the terms speed-strength and strength-speed (Delecluse, 1997; Zafeiridis et al., 2005). Sprint adaptations are load specific: using >20% BW is effective at improving initial acceleration while loads <10% BW are effective at improving maximal velocity (Petrakos et al., 2016). Alcaraz et al. (2009) proposed using a calculation which focused on subjects staying above their 90% maximum velocity and differing loads dependent on which phase of sprinting is being targeted[22]. Several studies showed that using light loads improved the acceleration phase of sprinting (Zafeiridis et al., 2005; Lockie et al., 2003). Locke et al. found that heavier loads were disruptive to normal sprint mechanics through a reduction in both stride length and frequency thus recommending light loads for training (Lockie et al., 2003). A systematic review by Alcaraz et al. examining the effectiveness of resisted sled training found an improvement in sprint performance when using loads less than 20% BW(CI 95%) (Alcaraz, 2018). Rumpf et al. in a study of 1,485 subjects found that training the acceleration phase of sprinting was most effective in a combined manner from 0-20m (Effect Size=-0.59; %change=-2.81) (Rumpf et al., 2016). Other studies show sled towing (pulling) with 80% BW (Effect size= 0.80) and found increases in horizontal ground reaction forces (Effect size= 0.95) and improvements in 5m and 20m sprint performances within soccer players (Morin et al., 2017). In youth athletes, Young found that sprint training resulted in general sport performance through the methods of hypertrophy and neural activation capacity (Young, 2006). Conversely, Hrysomalis found no training effect when comparing resisted moving training to unloaded training (Hrysomallis, 2012; Clark, 2011). Alcaraz et al. compared resisted sprints and found the sled sprinting group (0.20+/- 0.25 m/s, P=0.018, 1-beta=0.724, d=0.445) to increase performance in the transition phase from start to acceleration while the free-sprint training group (0.17 +/- 0.23 m/s, P=0.030, 1-beta=0.625, d=0.389) increased the maximum velocity phase (Alcaraz et al., 2014). Seitz et a/. studied different heavy sled pushes (75+%) on short distance sprints and found 75% BW was facilitating at 4-min (0.95 +/-2.00% faster), 8-min (-1.80 +/- 1.43%; p=0.001), and 12-min (-1.55+/-1.54%; p=0.003) while 125% BW was inhibitory at all time points (1.36 +/- 2.36%; p>0.65-2.59 +/- 2.90%; p=0.008) in sprint performance (Seitz, 2017).

DISCUSSION

The purpose of this literature review was to investigate sled sprinting as a means to increase horizontal strength. Furthermore, because sports primarily occur in a horizontal plane, to explore if sled sprinting could translateinto athletic performance as a secondary objective. Studies show that sled sprinting increases sprint performance through two methods (Petrakos et al., 2016; Alcaraz et al., 2018; Rumpf, 2016). Sled pushes are an effective to help athletes overcome the initial inertia associated with going into motion from a complete stop (Morin, 2017). The first 20m of sprinting have been defined as the acceleration phase and evidence supports a higher load leads to increased performance (Čoh, 2006; Yu, 2016). The acceleration phase of sprinting occurs between 0-20m when trained with an external resistance increases force production and ground reaction forces (Morin, 2017). Locke et al. found that while sled pushing increases initial inertial forces one drawback is lack of arm use which leads to decreased athletic transferability (Lockie et al., 2003). Arm swing is important in sprinting and contributes to both acceleration and maximal velocity (Mero et al., 1992). Even in sports where an object such as a ball is being handled by at least one limb still uses arm swing significantly (Brown et al., 2016; Wdowski, 2013). Thus, while sled pushing is an effective training modality it should be noted its lack of arm use may limit transferability into sports although it seems to increase horizontal force production. Sled pulling is the other modality used in resisted sprint training and Hyrsomalis found to elicit similar effects to sled pushing. Sled pulling is also capable of increasing force production and limb ground reaction force while incorporating arm swing. The uninhibited arm swing afforded by sled pulling means subjects can train similar biomechanics as to free sprinting (Alcaraz, 2018). The second objective of this study aimed to find data on sprinting as a strength exercise (Miller, 2016; Chelly, 2010). Previous studies have found sprinting as a potential strength exercise because of its inherent recruitment of type two muscle fibers (Harrison, 2009). Additionally, strength stimulus is tied to muscle recruitment, external load, and contraction velocities (Haff, 2015; Shephard, 2009; Baechle, 2008). Sprinting results in high amounts of muscle recruitment as shown using Henneman's recruitment principle (Harrison et al., 2009). The external load involves moving bodyweight at a high velocity at both types of isotonic contractions (concentric, eccentric). In sled sprinting, the external load is increased which results in greater strength gains. The ideal load has been disputed and may differ based on individual goals. This paper explored athletic performance which revealed that an external load of 20-30% BW to increase performance in acceleration while an external load of 10-20%% BW increases performance in the maximal velocity phase.

Conclusion

Sled sprinting is an effective modality to increase horizontal strength and athletic performance through horizontal GRF's. Sled sprinting can be used in two methods: sled pushing and sled pulling. Both methods are effective, however sled pulling may be more functional because of its ability to preserve uninhibited arm swing. External loads may be adjusted to suit individual goals, but the authors recommend 20-30% BW to increase acceleration and 10-20% BW to increase maximal velocity. Gajer et al. found maximal velocity is achieved between 50-70 meters in the 100m sprint thus it is recommended to perform these sprints for a distance of 60 meters for athletes to achieve maximal velocity without undue fatigue. Sled sprinting is a powerful modality because when compared to a depth jump; sprinting results in shorter ground contact times which means greater power[9,13]. When compared to Olympic weightlifting via a Tendo unit (Watts); sprinting results in higher watts which translates to increased force production[41,42]. Lastly, when analyzing athletics, we find that most sports occur in the horizontal plane. Most strength and conditioning programs are performed in the vertical plane which may not be optimizing performance. Thus, the authors recommend incorporating resisted sled sprinting as a means to increase horizontal strength and horizontal performance. It is important to note that resisted sprint programming should be individualized based on training age, experience, and motor control ability which can be made very specific through methods such as maximum velocity % and meters ran. However, using bodyweight is a quick and easy way to calculate external loads to begin a resisted sprint training program.

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