DETERMINING THE OPTIMAL LOAD FOR RESISTED SPRINT TRAINING WITH SLED TOWING. A PILOT STUDY.

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An excessive load in resisted sprint training can produce changes in running patterns. Load control is essential to ensure specificity of these training methods. The most common way to control is the percentage of speed lost in relation to maximum speed. The aim of the study was establishing the load for sprint training with sled towing in the maximum velocity phase. 12 athletes, Spanish national level, participated in the study. They run 30 m flying sprints, an unloaded sprint and sprints pulling loads of 6%, 10%, and 15% of their body mass, on a synthetic track surface wearing spikes. The regression equation obtained was: *% Body mass = (-0.8325 · % velocity) + 84.08*. This equation is specific for the type of surface used and the sled towing characteristics. Therefore, when using different surfaces and sled towings, specific equations should be calculated.

KEY WORDS: sprint, resisted training, athletics, maximum velocity

INTRODUCTION:

Sprint performance is a direct result of the impulse (mean force multiplied by contact time) applied by the athlete against the ground (Alexander, 1989). Therefore, one of the objectives of training is to increase the specific strength of the sprinters (Korchemny, 1985). This situation has led specialists to investigate new forms of training with the objective of obtaining greater levels of adaptation. The benefits of the use of resisted sprint running is that it recruits more muscle fibers, requires more neural activation (Faccioni, 1994a), and increases the load in hip extensor muscles (Faccioni, 1994b). These methods provoke a development of the specific strength and increase in the stride length (Costello, 1985; Tabachnik, 1992; Faccioni, 1994b; Donati, 1996; Lockie *et al.*, 2003).
The training principle of specificity states that for an exercise to be effective, it must maintain similar characteristics to the sport requirements (Young *et al.*, 2001; Sale, 2003). Different studies suggest that to maintain load specificity in sprints the horizontal velocity should not fall bellow 90% of the athlete's maximum velocity (Letzelter *et al.*, 1995; Jakalski, 1998; Lockie *et al.*, 2003). In fact, working out with excessive loads when using sled towing provokes a reduced stride length, and a diminished stride frequency (Elvira *et al.*, 2006). Furthermore, Lockie et al. (2003) proposed an equation to calculate the adequate load required in sprint training with sled towing: *% Body mass = (-1.96 · % velocity) + 188.99*. Their study was developed with athletes from various field sports in the acceleration phase.
This equation allows one to calculate the load for sled towing for acceleration phases of the sprint. However, as the maximum velocity phase has different characteristics than acceleration phase (Young *et al.*, 2001; Murphy *et al.*, 2003; Cissik, 2004), the work of maximum velocity required a different type of work and load. Therefore, the purpose was to develop an equation that accurately describes the relationship between towing loads and the resulting sprint velocity in the maximum velocity phase.

METHOD:

Data Collection: Twelve male participants were recruited for the study (Table 1). The participants were active competitive athletes who specialized in either sprints or decathlon, and all had previously used resisted sprint devices in their training. The participants were informed of the protocol and procedures prior to their involvement and written consent to participate was obtained.

Table 1. General characteristics of participants (mean ± *SD*). Leg length = medial malleolus to greater trochanter.

	Age (years)	Body mass (kg)	Height (cm)	Leg length (cm)	100m sprint performance (s)	Training experience (years)
Male (n=12)	21 ± 3	79.9 ± 6.9	179.0 ± 10.7	96.0 ± 7.2	11.13 ± 0.42	9 ± 2

The sprint trials were conducted on a synthetic track (Rekortan M99, APT Corp., USA) in an outdoor athletics stadium. Participants wore their own athletic training clothes and spiked sprint shoes. Before commencing the sprint trials the subjects were weighted in order to determine the load relative to 6% (sled mass), 10%, and 15% of their body mass. After that, the participants performed a sprint-specific warm-up.

A weighted sled (Power Systems Inc., Knoxville) was attached to the athlete by a 3.6 m cord and waist harness. When sprinting at maximum speed the angle of the cord to the horizontal was between 12.5º and 15.5º, depending on the athlete's body dimensions. The sled traveled on two parallel metal tubes about 500 mm long and 30 mm in diameter. The sliding surfaces of the base of the sled were smooth and bare. The load required on the sled was calculated using the equation: load = *([body mass x %body mass] – sled weight)*, where %body mass was worked out as a decimal (e.g., 5% body mass = 0.05), sled weight = 4.7 kg. The athletes performed four 30-m flying sprints, an unloaded sprint and sprints pulling loads of 6%, 10%, and 15% of their body mass, at maximum intensity using a run-in distance of 20 m from a standing start in order to find changes in maximum velocity. One trial was completed for each load (Hunter et al., 2004). The order for the trials was randomized for each participant and an unlimited rest period was given between trials to minimize the effects of fatigue on sprint performance. The rest period typically lasted about 6 min, which is sufficient for full recovery from repeated maximal sprints of short duration (Harris et al., 1976). The maximum velocity for the sprints was measured with a radar (StalkerPro Inc., Plano) with a record data frequency of 100 Hz. The wind velocity for all trials was measured using a wind gauge (Cantabrian, Cambridge), and trials in which the wind was not between –2 $m \cdot s^{-1}$ and 2 $m \cdot s^{-1}$ were repeated. Electronic timing gates (BioMedic, Barcelona) were placed at the start and finish of the 30–m flying sprint to record the sprint times.

Data Analysis: Descriptive statistics methods were used to calculate the means and standard deviations (SD). Pearson correlation coefficients were used to determine the interrelationship among %Bm load and maximum velocity variables. Alpha-level was set to $P \leq 0.05$.

RESULTS:

Mean maximum velocity, 30-m sprint time, load, % body mass, and % velocity of both unloaded and loaded sprinting situations are shown in Table 2. An increase in the time and a reduction of the speed is observed when the load increased.

Table 2. Maximum velocity, 30 m fly-sprint time, load, % body mass, and % velocity in unloaded and load 1, load 2, and load 3 sprints (n = 12). Max = maximum.

	Unloaded	Load 1	Load 2	Load 3
Variable	mean ± SD	mean ± SD	mean ± SD	mean ± SD
Max Velocity ($m \cdot s^{-1}$)	9.62 ± 0.54	9.07 ± 0.50	8.59 ± 0.41	8.09 ± 0.37
30 m fly-sprint time (s)	3.26 ± 0.18	3.40 ± 0.18	3.54 ± 0.17	3.81 ± 0.20
Load (kg)	0.0 ± 0.0	4.7 ± 0.0	7.9 ± 0.9	11.7 ± 1.0
% Body mass	0.0 ± 0.0	6.0 ± 0.5	10.1 ± 0.6	14.9 ± 0.5
% Velocity	100 ± 0	94 ± 3	89 ± 2	84 ± 3

The resultant velocities produced from the loads were converted to a percentage of the maximum velocity over 30-m fly sprints. These data were plotted against each other in order to produce the regression equation (Figure 1). The R2 value for the equation was 0.87. This value reflected the highly significant linear relationship ($p<0.001$). The regression equation obtained was: *% body mass = (-0.8325 · %velocity) + 84.08*, where % velocity = the required training velocity as a percentage of maximum velocity, e.g., 90% of maximum.

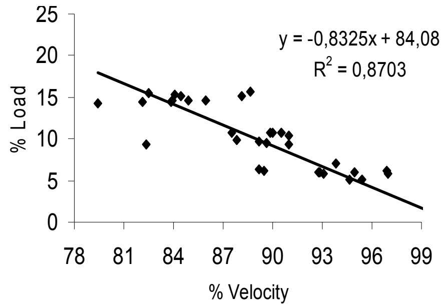

Figure 1. Regression analysis of the effect of increase in load (as a percentage of body mass) on velocity (as a percentage of maximum speed over 30 m).

DISCUSSION:

The training principle of specificity states that for an exercise to be effective, it must maintain similar characteristics to the sport requirements (Young *et al.*, 2001; Sale, 2003). Different studies suggest that to maintain load specificity in sprinting the horizontal velocity should not fall bellow 90% of the athlete's maximum velocity (Letzelter *et al.*, 1995; Jakalski, 1998; Lockie *et al.*, 2003). Thus, Lockie et al. (2003) proposed an equation to calculate the adequate load required in sprint training (acceleration phase) with sled towing: *% Body mass = (-1.96 · % velocity) + 188.99*. However, as the maximum velocity phase has different characteristics than acceleration phase (Young *et al.*, 2001; Murphy *et al.*, 2003; Cissik, 2004), the work of maximum velocity required a different type of work and load.
The current research was developed with the aim of establishing an equation that accurately describes the relationship between towing loads and the resulting sprint velocity in the maximum velocity phase. The results allow one to calculate a regression equation: *% Body mass = (-0.8325 • % velocity) + 84.08*. However, it should be noted that it has been calculated with only 12 male sprinters and decathletes with previous experience in resisted sprint training methods and with spiked shoes on tartan surface. Future studies should increase the number of the sample (~ 25 athletes) with the aim of raising the reliability of the equation.
The values presented in Tables 3 are only general reference values. They should be considered as estimate of work load. For example, timing during the season, as well as the shoes or surface used will affect the calculation. When applying the equation it should be kept in mind that the load applied to the athlete by a weighted sled depends on the coefficient of friction between the sled and the running surface, as well as on the weight of the sled. Therefore, the proposed equation is specific to the combination of sled and surface used in this study.

CONCLUSION:

This paper presents a new tool to calculate the load for sled towing in the maximum velocity sprint training. The equation lets coaches and strength trainers to calculate the load for resisted sprint training with sled towing. The Table 3 help to quickly establish the work loads for their athletes corresponding to their objectives. Therefore, if you are training to a 105 kg athlete and you want to work at 90% of his/her maximum velocity, you should use 9.61 kg when working the maximum velocity phase (30-60 m).

Table 3. Load (kg) required for sled towing in MAXIMUM VELOCITY TRAINING.

Individual Body Mass (kg)	**Maximum Velocity Training** 90%	92.5%	95%
120	10.99	8.49	5.99
115	10.53	8.13	5.74
110	10.07	7.78	5.49
105	9.61	7.43	5.24
100	9.16	7.07	4.99
95	8.70	6.72	4.74
90	8.24	6.37	4.49
85	7.78	6.01	4.24
80	7.32	5.66	3.99
75	6.87	5.31	3.74
70	6.41	4.95	3.49
65	5.95	4.60	3.25
60	5.49	4.24	3.00
55	5.04	3.89	2.75
50	4.58	3.54	2.50

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