ABSTRACT

Twenty four male Sport Science students, were assigned in this study in order to be examined the acute effects of different loading conditions on acceleration, maximum speed and final performance of a 50 m sprint run. A countermovement jump and a 50 m run without and with extra loading - 8, 15, 20% of subjects’ BM were performed in order leg power and running performance to be measured. ANOVA revealed significant interaction between loading conditions and performance (Wilks $\lambda F = 31.34$, $p = 0.000$, $n^2 = 0.967$). The 8% B.M. loading significantly affected performance at 40 m by 4.6 - 4.7% while the 15% BM loading at 20 and 40 m by 7.3 and 7.4% respectively. The 20% BM loading affected similarly running performance at 10 m and 40 m causing an increase in performance by 9.9% at both distances. Significant correlations were found between leg power and running performance for the selected distances at the loading conditions of 0, 8, 15% BM ($r = -0.440 - 0.553$), while a correlation between leg power and running performance with the load of 20%B.M. was found only for the distances 30, 40 and 50 m ($r = -0.419 - 0.565$). Subjects with higher leg power were more affected by large loads (15-20% BM) during the acceleration phase, while in those with lower leg power decreases occurred by all loading conditions. Consequently, resistance speed training using a weighted vest emerges an excellent means for either phase of the 0 - 50 meters.

Key Words: sprinting performance, resistance training.
INTRODUCTION

The ability to accelerate over short distances is the key to success in many individual and team sports such as sprints and football (19, 28). Therefore, many strength training methods and means have been used by researchers and coaches in order to improve the athletes’ acceleration and maximum speed by increasing muscle strength and power, which relationship has been thoroughly revealed (27). Despite the different methods and means applied various specific modes of resistance training are widely used in order to improve sprint performance (26). The most commonly resistance training methods used for speed improvement are: uphill running (24), sprint towing (22), sled towing (2, 19), running with arm and/or leg loading (3), parachute training (20) and running loaded with a weighted vest (4, 6, 7, 10).

The positive effects of weighted vest training in leg power and speed performance have been previously demonstrated. Increased leg strength and power as well as decreased contact times has been shown to occur in a previous study (4) when loads equal to 11-13% of BM were used. Similar results were reported in a group of sprint athletes who underwent a training program for power improvement with a load resistance of approximately 7-8% of their body mass (6). Moreover, Cronin et al (10) compared sprint kinematics using sled towing and loaded vest with relative loads applied equal to 15% and 20% of body mass. They concluded that the use of sled towing and weighted vest had different effects on some kinematic parameters, specifically, when the greater load (20% of BM) was used.

However, a few data exist on the resistance-load selection taking into consideration the fact that the resistance load being applied for sprint training should not have a negative impact- reduction more than 10% of the athletes’ maximum velocity, in order the proper running technique to be maintained (13, 19).

To our knowledge there is not adequate information concerning the ideal resistance that should be applied when a loaded vest is used during a sprint training session. Several sled towing studies have used a loading estimation based on the rate of speed that is lost over the acceleration phase (19) or the maximum speed (2) of the sprint curve taking into consideration that optimal performance in each phase requires different neuromuscular characteristics (29) Therefore, the purpose of this study was to examine the acute effects of different resistive loading conditions applied (0%, 8%, 15%, 20% of body mass), with a weighted vest worn by the subjects, on acceleration, maximum speed and the final performance of a 50m run. The selected weighted vest loads were expected to affect in a different way the running performance of the different sub distances which might indicate the phases of the speed curve of a 0 - 50 m run (approx. 0 - 20 acceleration, 20 - 40 max.
speed). More specifically, the application of heavier loads was expected to better affect the acceleration phase compared to the lighter loads which are considered to be the best for maximum speed improvement (19). Additionally, the running performance was expected to be related to subjects' leg power and body mass.

METHODS

Subjects

Twenty four Sports Science students, 18-23 years old, height $178 \pm 0.05$ cm, body mass $74.2 \pm 8.9$ kg, % body fat $11.3 \pm 3.3$, with a two year sprint or soccer training experience were assigned to participate in this study. An informed written consent was obtained from each participant at the beginning of the experimental procedure. The study was approved by the University's Institutional Review Board and all methods and procedures were in accordance with the Helsinki declaration of 1975, as revised in 1996.

PROCEDURES

All running tests performed on a synthetic outdoor track while the anthropometric characteristics and the jumping performance (Counter Movement Jump-CMJ) were measured in laboratory conditions. Before the jumping tests and the sprint trials, all subjects performed a warm-up protocol consisting of 8 minutes running at their own pace, 8 minutes of dynamic stretching, 10 minutes of running technique exercises and two sub-maximal short distance sprints (0-20-30 m).

All study procedures were designed and executed on five different days separated by a minimum of 48h rest between. Anthropometric measurements and the jumping tests were measured at the first experimental day. Subjects were assigned in two subgroups according to their jumping performance level: HCMJ (High Countermovement Jump performance) and LCMJ (Low Countermovement Jump performance).

Height was measured to the nearest 0.1 cm (Seca Bodymeter 208, Germany) and body weight to $\pm 100$ gr (Seca Robusta 813, Hamburg, Germany). The percentage of body fat was estimated after measuring 7 different skinfolds (triceps, brachial, iliac, abdominal, thoracic, scapular and femoral), as described by Heyward and Stolarczyk (14). Jumping performance (CMJ) was measured using the Optojump device (Optojump, Microgate, Italy) and jumping tests performed as they were described by Bosco et al (4). All participants were instructed to leave the ground with the knees and ankles ex-
tended and land at the same spot in an upright position. The best of two trials, separated by 30 s rest, was used for analysis. The ICC for CMJ was 0.973, (p < 0.001).

The maximum sprinting performance without external loads was measured at the second day, while that with the lighter external load (8% of their body mass) was measured at the third experimental day. The performance with the medium (15% B.M.) and the heavier loads (20% BM) was measured during the fourth and fifth experimental day respectively.

A recording system of six wireless electronic photocells and reflectors (Polifemo Radio Light-Microgate, Italy) was used in order to record running times of the sub-distances 0 - 10 - 20 - 30 - 40 - 50 m, and to estimate the relevant speed phases of a 50 m sprint run, with a recording accuracy of ±4/1000 sec.

The selected distances are the same with those usually used by coaches in order to easily indicate and evaluate both the acceleration and/or the maximum speed phase (8), since both are crucial determinants of sprinting performance (1, 9, 29). Moreover, the three different external loads of 8% (8), 15% and 20% BM (10) were chosen in order the participants to experience a light, a medium and a heavier loading condition.

The wind velocity for all trials was measured using a wind gauge (Cantabrian, Cambridge, England). The required wind velocity range was –2 and 2 m/s. That range can produce a little change of about ±1% in 30 m sprint time performance from a zero wind result (30).

All subjects performed two 50 m flying start sprints at maximum intensity-speed for each unloaded or loaded condition (0, 8, 15, 20% B.M.). The best time of each trial was selected in order to be analyzed. A full recovery rest time of about 5-6 minutes was given in between the two trials while a forty eight hour rest time was given in between each of the 5 experimental testing days. The rest periods were selected as the ones which are sufficient for full recovery from repeated maximum sprints of short duration (15).

The extra loading conditions achieved with the subjects' being loaded wearing on the ZFO-40LBS Adjustable Weighted Vest (U.S.A.).

**Statistical analysis**

ANOVA with repeated measures was used to analyze the possible differences between the running performance for the chosen distances (10 - 20 - 30 - 40 - 50 m) and sub distances (10 - 20, 20 - 30, 30 - 40, 40 - 50 m) with the different loading conditions applied (0, 8, 15, 20% BM), in all subjects and in the two subgroups – with the higher and the lower jumping performance. Where necessary, one way ANOVA was used for the comparison of the
sprint performance differences between a) the chosen distances or b) the sub distances-different phases for each loading condition, while Bonferroni post-hoc analyses were used in order to locate the existing differences. Multiple correlation coefficients were used to correlate anthropometric characteristics, jumping and running performance of the participants. SPSS v. 17.0 was used, while the alpha level was set to $\alpha = 5\%$.

**RESULTS**

Significant interactions were observed between loading conditions and running performance ($\text{Wilks } \Lambda = 31.34, p = 0.000, \eta^2 = 0.967$). Moreover, significant main effects were also observed for running performance at the different distances (0-50 m) ($\text{Wilks } \Lambda = 4493.34, p = 0.000, \eta^2 = 0.999$) and for the running performance after the application of selected loading conditions 0-20% ($\text{Wilks } \Lambda = 8389.16, p = 0.000, \eta^2 = 0.982$) respectively.

Post-hoc analysis showed significant differences between performance in 10, 20, 30, 40 and 50 m after the application of selected loading conditions (0 vs 8%, 0 vs 15%, 0 vs 20% B.M.) respectively ($p < 0.000$).

Table 1. Running performance at selected distances with different weighted vest loading conditions and percentage differences between the unloaded and loaded conditions.

<table>
<thead>
<tr>
<th></th>
<th>10 m</th>
<th>20 m</th>
<th>30 m</th>
<th>40 m</th>
<th>50 m</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>1.72 ± 0.07</td>
<td>3.00 ± 0.08</td>
<td>4.33 ± 0.13</td>
<td>5.48 ± 0.18</td>
<td>6.67 ± 0.23</td>
</tr>
<tr>
<td>8%</td>
<td>1.79 ± 0.07</td>
<td>3.14 ± 0.10</td>
<td>4.53 ± 0.16</td>
<td>5.76 ± 0.19</td>
<td>6.98 ± 0.21</td>
</tr>
<tr>
<td></td>
<td>-4.1%</td>
<td>-4.7%</td>
<td>-4.6%</td>
<td>-5.1%</td>
<td>-4.6%</td>
</tr>
<tr>
<td>15%</td>
<td>1.84 ± 0.08</td>
<td>3.22 ± 0.10</td>
<td>4.60 ± 0.14</td>
<td>5.89 ± 0.19</td>
<td>7.12 ± 0.24</td>
</tr>
<tr>
<td></td>
<td>-6.9%</td>
<td>-7.4%</td>
<td>-6.9%</td>
<td>-7.5%</td>
<td>-7.3%</td>
</tr>
<tr>
<td>20%</td>
<td>1.89 ± 0.07*</td>
<td>3.28 ± 0.08*</td>
<td>4.73 ± 0.15*</td>
<td>6.02 ± 0.20*</td>
<td>7.26 ± 0.24*</td>
</tr>
<tr>
<td></td>
<td>-9.9%</td>
<td>-9.3%</td>
<td>-9.2%</td>
<td>-9.9%</td>
<td>-7.3%</td>
</tr>
</tbody>
</table>

* Bonferroni post-hoc, (0 vs 8%, 0 vs 15%, 0 vs 20%) $p < 0.000$
From the results presented on Table 1, it seems that the 8%B.M. load reduced the running performance by 4.1 - 5.1% for all sub distances/speed phases. Running performance was also reduced by 6.9 - 7.5% and 8.3 - 9.9% after the application of the medium 15% B.M. and heavier 20% B.M. load respectively.

The lighter load 8% B.M. affected running performance at 40m by 5.1% while running performance at 10 m was less affected (4.1%). Running performance was affected equally at 20 and 40 m (7.3 - 7.4%) with an external load of 15%, while heavier loads seem to affect similarly running performance at 10 and 40 m by 9.9%.

Significant interactions were observed between loading conditions and running performance in different phases (Wilks \( \Lambda = 5.65, p = 0.001, \eta^2 = 0.76 \)). Moreover, significant main effects were also observed for running performance in different phases 0 - 50 m (Wilks \( \Lambda = 75.93, p = 0.000, \eta^2 = 0.910 \)) and for running performance after the application of the selected loading conditions 0 - 20% (Wilks \( \Lambda = 8389.16, p = 0.000, \eta^2 = 0.982 \)).

**Table 1. Running performance at selected distances with different weighted vest loading conditions and percentage differences between the unloaded and loaded conditions.**

<table>
<thead>
<tr>
<th></th>
<th>10 m</th>
<th>20 m</th>
<th>30 m</th>
<th>40 m</th>
<th>50 m</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>1.72 ± 0.07</td>
<td>1.28 ± 0.03</td>
<td>1.32 ± 0.03</td>
<td>1.15 ± 0.01</td>
<td>1.19 ± 0.02</td>
</tr>
<tr>
<td>8%</td>
<td>1.79 ± 0.07</td>
<td>1.35 ± 0.03</td>
<td>1.39 ± 0.04</td>
<td>1.26 ± 0.02</td>
<td>1.22 ± 0.02</td>
</tr>
<tr>
<td>15%</td>
<td>1.84 ± 0.08</td>
<td>1.38 ± 0.02</td>
<td>1.41 ± 0.04</td>
<td>1.26 ± 0.02</td>
<td>1.23 ± 0.02</td>
</tr>
<tr>
<td>20%</td>
<td>1.89 ± 0.07*</td>
<td>1.39 ± 0.03*</td>
<td>1.45 ± 0.05*</td>
<td>1.29 ± 0.03*</td>
<td>1.24 ± 0.03*</td>
</tr>
</tbody>
</table>

* Bonferroni post-hoc 10-20: 0 vs 8, 0 vs 15, 0 vs 20 (p < 0.000)
20-30: 0 vs 8, 0 vs 15, 0 vs 20, 8 vs 20 (p < 0.000)
30-40: 0 vs 8, 0 vs 15, 0 vs 20, 8 vs 20 (p < 0.000)
40-50: NS

Post hoc results revealed significant differences between performances in distance/phase 10-20 m after the application of selected loading conditions.
(0 vs 8%, 0 vs 15%, 0 vs 20% B.M.), (p < 0.000). Significant differences were, also, observed between performances in distances 20 - 30 and 30 - 40 m after the application of the selected loading (0 vs 8%, 0 vs 15%, 0 vs 20% and 8 vs 20% B.M.), (p < 0.000).

Table 3. Percentage changes in running performance after the application of selected loading conditions in different distance 0 - 50 m phases.

<table>
<thead>
<tr>
<th></th>
<th>10 - 20 vs 20 - 30</th>
<th>20 - 30 vs 30 - 40</th>
<th>30 - 40 vs 40 - 50</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>3.9% ▼</td>
<td>13.5% ▲</td>
<td>3.5% ▲</td>
</tr>
<tr>
<td>8%</td>
<td>2.9% ▼</td>
<td>11.5% ▲</td>
<td>0% ▲</td>
</tr>
<tr>
<td>15%</td>
<td>2.2% ▼</td>
<td>10.6% ▲</td>
<td>2.4% ▲</td>
</tr>
<tr>
<td>20%</td>
<td>4.3% ▼</td>
<td>11.0% ▲</td>
<td>3.9% ▲</td>
</tr>
</tbody>
</table>

Significant interaction between loading conditions and running performance was additionally observed for the group with the lower jumping performance (LCMJ) (Wilks ΛF = 3643344.95, p = 0.000, η² = 1.000). A significant main effect was observed between the running performances at the different distances (0 - 50 m) (Wilks ΛF = 127234.43, p = 0.000, η² = 0.999) and the running performances at the different loads (0 - 20%) (Wilks ΛF = 10813.58, p = 0.000, η² = 0.982).

Post-hoc analysis showed significant differences in running performance between loads (0 vs 15%, 0 vs 20%) p < (0.05 - 0.001) for the 10 m, while the differences for the running performances at the distances 30, 40 and 50 m occurred between 0 vs 8%, 0 vs 15%, 0 vs 20%, p < (0.05 - 0.001). ANOVA results of the subgroup with the HCMJ showed a significant interaction between loading conditions and running performance (Wilks ΛF = 30674.67, p = 0.000, η² = 0.998). Significant main effect was observed between running performances in different distances (0 - 50 m) (Wilks ΛF = 365138.60, p = 0.000, η² = 1.000) and the running performances with the different loading conditions (0-20%B.M.) (Wilks ΛF = 40847.81, p = 0.000, η² = 0.998).

Post-hoc analysis showed significant differences in running performance between loads (0 vs 8%, 0 vs 15%, 0 vs 20%), p < (0.05 - 0.001) for the 10 and 20 m, while the differences for the running performances at the distances 30, 40 and 50m occurred between 0 vs 15%, 0 vs 20%, p < (0.05 - 0.001).
### Table 4. Running performance at selected distances with different weighted vest loading conditions and percentage differences between the unloaded and differently loaded conditions for the subjects with the lower and higher jumping performance.

<table>
<thead>
<tr>
<th></th>
<th>10 m</th>
<th>20 m</th>
<th>30 m</th>
<th>40 m</th>
<th>50 m</th>
</tr>
</thead>
<tbody>
<tr>
<td>HCMJ 0%</td>
<td>1.69 ± 0.05†</td>
<td>2.96 ± 0.06†</td>
<td>4.25 ± 0.09§</td>
<td>5.40 ± 0.12§</td>
<td>6.55 ± 0.16§</td>
</tr>
<tr>
<td>LCMJ 0%</td>
<td>1.76 ± 0.09†</td>
<td>3.07 ± 0.13</td>
<td>4.42 ± 0.17‡</td>
<td>5.62 ± 0.25‡</td>
<td>6.84 ± 0.31‡</td>
</tr>
<tr>
<td>HCMJ 8%</td>
<td><strong>1.74 ± 0.06</strong></td>
<td><strong>3.07 ± 0.05</strong></td>
<td>4.43 ± 0.08**</td>
<td><strong>5.65 ± 0.11</strong></td>
<td>6.64 ± 0.14*</td>
</tr>
<tr>
<td></td>
<td>2.9%</td>
<td>3.7%</td>
<td>4.2%</td>
<td>4.6%</td>
<td>1.4%</td>
</tr>
<tr>
<td>LCMJ 8%</td>
<td>1.86 ± 0.08</td>
<td>3.25 ± 0.15</td>
<td>4.66 ± 0.23</td>
<td>5.91 ± 0.28</td>
<td>6.91 ± 0.28</td>
</tr>
<tr>
<td></td>
<td>5.7%</td>
<td>5.9%</td>
<td>5.4%</td>
<td>5.6%</td>
<td>1%</td>
</tr>
<tr>
<td>HCMJ 15%</td>
<td><strong>1.80 ± 0.07</strong></td>
<td><strong>3.17 ± 0.08</strong></td>
<td>4.55 ± 0.09**</td>
<td><strong>5.77 ± 0.11</strong></td>
<td><strong>6.98 ± 0.13</strong></td>
</tr>
<tr>
<td></td>
<td><strong>6.5%</strong></td>
<td><strong>7%</strong></td>
<td><strong>7%</strong></td>
<td><strong>6.9%</strong></td>
<td><strong>6.5%</strong></td>
</tr>
<tr>
<td>LCMJ 15%</td>
<td>1.89 ± 0.08</td>
<td>3.30 ± 0.12</td>
<td>4.75 ± 0.19</td>
<td>6.10 ± 0.26</td>
<td>7.31 ± 0.34</td>
</tr>
<tr>
<td></td>
<td>11.3%</td>
<td>11%</td>
<td>7.4%</td>
<td>8.5%</td>
<td><strong>6.9%</strong></td>
</tr>
<tr>
<td>HCMJ 20%</td>
<td><strong>1.88 ± 0.05</strong></td>
<td>3.25 ± 0.07</td>
<td><strong>4.68 ± 0.09</strong></td>
<td><strong>5.93 ± 0.11</strong></td>
<td>7.12 ± 0.12*</td>
</tr>
<tr>
<td></td>
<td><strong>11.2%</strong></td>
<td><strong>9.8%</strong></td>
<td><strong>10.1%</strong></td>
<td><strong>9.8%</strong></td>
<td><strong>8.7%</strong></td>
</tr>
<tr>
<td>LCMJ 20%</td>
<td>1.91 ± 0.08</td>
<td>3.33 ± 0.10</td>
<td><strong>4.83 ± 0.27</strong></td>
<td><strong>6.16 ± 0.30</strong></td>
<td><strong>7.45 ± 0.35</strong></td>
</tr>
<tr>
<td></td>
<td>8.5%</td>
<td>8.5%</td>
<td>9.3%</td>
<td>9.6%</td>
<td><strong>8.9%</strong></td>
</tr>
</tbody>
</table>

*p < 0.05, **p < 0.01 significant differences between subjects with the weak and strong CMJ performance
† significant differences in speed performance between loads (0 vs 15%, 0 vs 20%) p < (0.05)
‡ significant differences in speed performance between loads (0 vs 8%, 0 vs 15%, 0 vs 20%) p < (0.05-0.001) respectively.
§ significant differences in speed performance between loads (0 vs 15%, 0 vs 20%) p < (0.05) respectively.

There was no significant correlation found between the subjects’ body mass and their running performance at 10, 20, 30, 40 and 50 m with or without the external loads. Significant correlations were observed between jumping and running performance for the distances 10, 20, 30, 40, 50 with loading conditions of 0, 8, 15 % BM (r = −0.440 − −0.553). However, corre-
loration between jumping performance and the heavier load (20% B.M.) found only for the distances of 30, 40, 50m. \(r = -0.419 - -0.565\).

No significant correlation was found between the different loading conditions of 8, 15 20% B.M. and the sprinting performance for the distances 10 - 20 m and the maximum speed distance 30 - 40 m.

**DISCUSSION**

A number of studies have documented the acute effects of different resistive training devices on sprint performance (9, 16, 28). However, only a few studies have been performed concerning the use of the vest's loading in order to improve speed running without affecting optimal kinematic/running characteristics (1, 9, 10).

Consequently, the information that emerges from this study is expected to have significant research and practical interest for speed training since it investigates the effects of different loading conditions on speed reduction, following recent suggestions proposed (16).

The purpose of this study was to investigate the acute effects of different loading conditions (0%, 8%, 15%, 20% of BM) on acceleration, maximum speed and the final performance for a running distance of 50m. The results of this study showed that significant differences in participants' running performance exist for all distances and phases regarding the unloading and loading conditions, confirming the theoretical hypothesis of this study. Similar results were also observed in a study (1) whereas a reduction of the speed performance was revealed without the running technique being affected, in sprinters and jumpers after the application of different running methods and means (parachute, sled and weighted belt) for legs' strength and power increase. It is shown that the three types of resisted sprint training devices are all appropriate for training in order to improve either the acceleration or the maximum velocity phase. The same researchers (1, 2) also found a significant and progressive reduction of speed in maximum velocity phase by applying three different loading conditions using a weighted sled (6, 10, and 15% B.M.) in a group of sprinters, jumpers and decathletes during a 30m speed run. Similar results in speed reduction were also demonstrated by Maulder et al (21) regarding the acceleration phase. In this study the external loads of 10% B.M. appeared to cause a speed reduction in a distance of 10m by 8%, while the load of 20% B.M. caused a 15% reduction in performance which far outstrips the theory been proposed (17) which allows a maximum speed reduction of 10% in order the proper running technique to be maintained.

From the results of the present study it is revealed that the participants developed their maximum speed between 20 and 40 meters. The distance of 40 m is the most affected as shown by the reduced observed performance of
7.5% - 9.9%, while the most important finding of this study is related to the heavier loading condition (20% BM), which appears to affect equally the first 10m and 40m causing reduction of running performance.

The results of this study are partially confirmed (21), suggesting that both light and heavy loads are important training tools for improving speed performance for different speed phases and sprint distances. It is known that at the starting phase of a short sprinting run great forces are exerted on the block and the ground while the athlete is required to be moved as rapidly as possible away from the starting block (12, 21). In practice, training without resistance should be mostly applied for distances longer than 20m, while resistance training can be better used for distances of less than 20m, taking into account factors such as anthropometric, morphological and neuromuscular characteristics of trainees besides their level of specific physical capabilities (16).

Sprinting requires high acceleration ability and consequently satisfactory strength and power, which highlights the significance of the relationship between power and speed performance as these are determined by a variety of jumping tests and speed measurements (27).

The results of the present study showed significant correlations between jumping and speed performance under loading conditions of 8% B.M. at 10, 20, 30, 40 and 50 m. Moreover, similar correlations were found under loading conditions of 15% B.M. at distances of 20, 30, 40 and 50 m. However, relationship between jumping and running performance under the loading conditions of 20% B.M. was observed only for the distances of 30, 40 and 50 m. It is important to be mentioned that during acceleration phase there was a satisfactory correlation between loading conditions of 15 and 20% B.M. This probably can be attributed to the characteristics of the jumping test (CMJ) which has proven to provide good information about long-lasting stretch/shortening cycles (13).

Subjects' training level seems to be a crucial factor for the interpretation of such studies even if the conflicting results highlight the need for future studies comparing populations with different age, training levels and sport (9, 11, 25). Well-trained participants seem to benefit more from a new resistance stimulus, translating these adaptations in excessive performance (9). In this research, the HCMJ subjects showed a significant reduction of their running performance regarding the 10 first meters after the application of 15 and 20% B.M. loading conditions, while the LCMJ group had a significant reduction of running performance after the application of all loading conditions (8, 15 20% B.M). This information highlights that there is not a specific optimal load for subjects with lower leg power as determined by the counter-movement results for all distances of the speed curve.

In conclusion, the results of this study show that loading the subjects with the weighted vest by 8, 15, and 20% of their body mass it significantly reduces running performance, within the limitation of the 10% of speed re-
duction that may not exert changes in sprinting technique. The research aimed to provide useful information to coaches using as subjects light-trained persons. External loads of 8 to 20% affected differently the selected distances of the speed curve. This observation is important since many coaches believe that the athletes should not use exercises with extra loading due to possible excessive changes in their running technique in or near the competitive season. From the results of the present study it is obvious that all loads seem to be useful for speed development according to the different phases of the speed curve but loads should be carefully applied to avoid fatigue. Besides, running wearing a weighted vest, loaded proportionally, might have an effect in recruiting more and differently muscle fibers that would not have been activated in un weighted conditions, forcing also to an enhancement of the neural activation thus resulting to an increase of speed in non resisted sprinting. Athletes and coaches should consider the use of the weighted vest when they are doing resistive training because it is easy to be used with light, heavy or not at all loading without affecting running technique. Because of all mentioned above and especially because of vest’s practical applicability on training for speed development and running performance enhancement, further studies should focus on its use with various loads on (or finding the optimal individual loads to be applied) for not only training for strength and power but also as part of a dynamic warm up, developing a potentiated response of the neuromuscular system before any competitive running or jumping performance.

REFERENCES


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