Effect Of High and Low Velocity Ballistic Training on Acceleration Speed Among Novice College Athletes
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ABSTRACT

The purpose of the study was to find out the effect of high and low velocity ballistic training on acceleration speed among novice college athletes. To achieve this purpose of the study, forty-five male students studying in department of physical education, Annamalai university, Chidambaram, Tamil Nadu, India, were randomly selected and divided into three groups of fifteen each. The age of the subjects was ranged from 18 to 24 years. This study consisted of two experimental variables (high velocity ballistic training (HVBT) and low velocity ballistic training (LVBT)). The allotment of these groups was done at random, thus Group-I underwent high velocity ballistic training, Group-II underwent low velocity ballistic training for three days per week for twelve weeks, Group-III acted as control. All the subjects were tested prior to and after the experimentation period. The collected data were statistically treated by using ANCOVA, and 0.05 level of confidence was fixed to test the significance. When the obtained ‘F’ ratio was significant, Scheffe’s post hoc test was used to find out the paired mean difference. The results of the study revealed that there was a significant difference among high velocity ballistic training group, low velocity ballistic training group as compared to control group on acceleration speed. And also, it was found that there was significant improvement on acceleration speed due to high velocity ballistic training group as compared to low velocity ballistic training group among novice college athletes.

KEY WORDS: High velocity ballistic training, Low velocity ballistic training, Acceleration speed.
Introduction

Improving athletic performance in already strong well-trained athletes requires sophisticated resistance training programs that contain a great deal of specificity and variability. In contrast, previously untrained individuals with low levels of strength display training induced improvements in muscular function that are easily invoked and relatively non-specific (Wilson et al., 1997). In fact, improvements in athletic performance were similar in relatively week individuals exposed to either ballistic power training or heavy strength training for 10 weeks. These performance improvements were mediated through neuromuscular adaptations specific to the training stimulus. The ability of strength training to render similar short-term improvements in athletic performance as ballistic power training, coupled with the potential long-term benefits of improved maximal strength, makes strength training a more effective training modality for relatively weak individuals (Cormie et al., 2010).

Ballistic training power recruits the muscle fibers of the weightlifter and makes them move faster. This is important because these muscle fibers have the greatest potential for growth and strength. Ballistic training requires the muscles to adapt to contract very fast and forcefully. This training requires the central nervous system to coordinate and produce the greatest amount of power in the shortest time possible (Cormie et al., 2011). Ballistic resistance training includes releasing the weight barbell into the air without decelerating phase by requiring weightlifter to accelerate during the entire range of motion to the point of overhead position. The most commonly used ballistic training exercise in athletic training is the jump squat, bench press throw, which many prefer for strength and conditioning, also heavy back squat is used for explosive power development (Lake et al., 2012).

Ballistic exercises are programmed by increasing the load required to be expected usually, these exercises are performed across a variety of loading conditions from 30 – 90% of 1RM in a similar traditional resistance training exercise such as the squat or bench press based on the specific exercise utilized and the requirements of the sport from the continued acceleration during the range of motion, concentric velocity, force, power and muscle activation are higher during a ballistic movement in comparison to a similar traditional resistance training exercise (McBride et al., 2002, and Rahimi & Behpur, 2005).
Free sprint training, or sprint training without the use of any external equipment, forms the basis for most speed training programs. Free sprint training has shown to increase running velocity over short distances (i.e., 15–20 m) (Kristensen et al., 2006). Markovic et al., (2007) also found that 10 weeks of FST increased isometric force production during a bilateral squat in male physical education students. To date, the effects of FST on initial acceleration step characteristics have not been conclusively investigated. Kristensen et al. (2006) measured stride length and frequency during a 22-m sprint in trained subjects, but they did not measure the initial 2 m. Given the importance of the first few meters of a sprint (Murphy et al. 2003), biomechanical analyses are an important tool for assessing the first few steps of a short sprint. Byrne et al., (2014) concluded that the addition of three depth jumps resulted in a 5% improvement of 20 m running compared to a traditional warm-up. However, little is known regarding when these ballistic exercises are used before Olympic racing distances, such as the 100 m. Moreover, little is known about the effects of using post-activation potentiation strategies on the biomechanical variables during running. Running performance depends on the stride parameters and, for instance, the optimal ratio between stride length (SL) and stride frequency (SF) enables maximal sprinting velocity and efficiency Krzysztof and Mero (2013). This relationship is conditioned by the neuromuscular regulation of movement, morphological characteristics, motor abilities and energy substrates, all of which can be influenced by warm-up tasks Neiva et al. (2014). Thus, the present study was undertaken to explore the effect of high and low velocity ballistic training on acceleration speed among novice college athletes.

Methodology

The purpose of the study was to explore the effect of high velocity and low velocity ballistic training on acceleration speed among novice college athletes. To achieve this purpose, forty-five male students studying bachelor’s degree in the department of Physical Education, Annamalai University, Chidambaram, Tamil Nadu, India, were selected as subjects at random. The selected subjects were randomly divided into three groups and each group consists of fifteen subjects. The groups were randomly segregated as high velocity ballistic training group, low velocity ballistic training group and control group. Group-I underwent high velocity ballistic training programme, group – II underwent low velocity ballistic training programme for three days per week for twelve weeks. Group-III acted as control and they did not participate in any special training programmes.
Acceleration speed was selected as criterion variable and was measured by acceleration speed with 30 meters dash in nearest one tenth of a second. The subjects of all three groups were tested on selected dependent variables, prior to and immediately after the training programme.

**Training Load**

The experimental group-I underwent high velocity ballistic training and group-II underwent low velocity ballistic training regimen for a period of twelve weeks. The training regimen for high and low velocity ballistic training consisted three set eight exercises per day, three days per week. After selecting the exercise 1 RM was found for each exercise separately. 1RM is the maximum amount of weight a person can successfully lift one time only through the full range of motion. High velocity ballistic group started with 60% of intensity and it was increased once in two weeks by 5% and 3 sets x 12 repetitions was given twelve weeks. Low velocity ballistic group started with 60% of intensity and it was increased once in two weeks by 5% and 3 sets x 6 repetitions was during given for twelve weeks and rest interval of two minutes between repetition and five minutes between set was continued. The control group did not participate in any special training during this period.

**Statistical Technique**

All the subjects of three groups were tested on dependent variables prior to and immediately after the training programme. The analysis of covariance (ANCOVA) was used to analyze the significant difference, if any among the groups. Since, three groups were compared, whenever the obtained ‘F’ ratio for adjusted post-test was found to be significant, the Scheffe’s post hoc-test was applied to find out the paired mean differences, if any. The .05 level of confidence was fixed as the level of significance to test the ‘F’ ratio obtained by the analysis of covariance, which was considered as appropriate and the results are presented below.

**Result of Study**

The influence of low and high velocity ballistic training on each criterion variables were analyzed separately and the results are presented below.
Table-I

ANACOVA FOR BEFORE TRAINING AND AFTER TRAINING ON ACCELERATION SPEED OF EXPERIMENTAL AND CONTROL GROUPS

<table>
<thead>
<tr>
<th></th>
<th>HVBTG</th>
<th>LVBTG</th>
<th>CG</th>
<th>SOV</th>
<th>SS</th>
<th>df</th>
<th>MS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Before Training Mean SD</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>4.74</td>
<td>4.72</td>
<td>4.76</td>
<td>B</td>
<td>0.016</td>
<td>2</td>
<td>0.008</td>
</tr>
<tr>
<td></td>
<td>0.140</td>
<td>0.136</td>
<td>0.144</td>
<td>W</td>
<td>0.829</td>
<td>42</td>
<td>0.20</td>
</tr>
<tr>
<td>After training Mean SD</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>4.22</td>
<td>4.49</td>
<td>4.74</td>
<td>B</td>
<td>1.99</td>
<td>2</td>
<td>0.994</td>
</tr>
<tr>
<td></td>
<td>0.143</td>
<td>0.197</td>
<td>0.179</td>
<td>W</td>
<td>1.28</td>
<td>42</td>
<td>0.031</td>
</tr>
<tr>
<td>Adjusted Posttest Mean</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>4.22</td>
<td>4.50</td>
<td>4.73</td>
<td>B</td>
<td>1.91</td>
<td>2</td>
<td>0.959</td>
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<td></td>
<td></td>
<td></td>
<td></td>
<td>W</td>
<td>1.41</td>
<td>41</td>
<td>0.028</td>
</tr>
</tbody>
</table>

*Significant F = (df 2,42) (0.05) = 3.22; (P ≤ 0.05) and F = (df 2,41) (0.05) = 3.23; (P ≤ 0.05)

It is clear from Table- I that before experimental intervention the mean values on acceleration speed for HVBTG is 4.74, LVBTG is 4.72 and CG is 4.76. The obtained ‘F’ ratio 0.40 is less than the table value of 3.22 required for df2 and 42 at 0.05 level of significance. It is inferred that there is statistically no significant variation on acceleration speed among HVBTG, LVBTG and CG before the commencement of training programme.

The mean scores secured by the HVBTG, LVBTG and CG after experimental interventions are 4.22, 4.49 and 4.74 respectively. The ‘F’ ratio of 32.49 arrived at by the statistical calculation is higher than the table value of 3.22 required for df 2 and 42 at 0.05 level of significance. It reveals that all the three groups have demonstrated significant variations on acceleration speed at the end of the training programme.

Table -I further shows that the adjusted post-test mean values for HVBTG is 4.22, LVBTG is 4.50 and CG is 4.73, which resulted with an ‘F’ ratio of 34.23 and it is higher than the table value of 3.23 required for df 2 and 41 at 0.05 level of significance. It is found that significant differences exist among the three groups on acceleration speed after adjusting the initial mean difference on the post-test means.
In order to determine which of the paired means have significant differences, Scheffe’s test was computed and the result is presented in table - II.

**TABLE – II**

**SCHEFFE’S POST HOC TEST FOR THE ADJUSTED POST-TEST PAIRED MEAN DIFFERENCES ON ACCELERATION SPEED**

<table>
<thead>
<tr>
<th>ADJUSTED POST TEST MEANS</th>
<th>Confidence Interval</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>HVBTG</strong></td>
<td><strong>LVBTG</strong></td>
</tr>
<tr>
<td>4.22</td>
<td>4.50</td>
</tr>
<tr>
<td>4.22</td>
<td>4.73</td>
</tr>
<tr>
<td>4.50</td>
<td>4.73</td>
</tr>
</tbody>
</table>

*Significant, (p ≤ 0.05)*

Table II shows that the adjusted post- test paired mean difference between HVBTG and LVBTG, HVBTG and CG and LVBTG and CG are 0.28, 0.51 and 0.23 for acceleration speed respectively. All the three mean differences are higher than the confidence interval of 0.15 required for significance at 0.05 level of confidence. It is inferred that the twelve weeks of HVBTG and LVBTG have significantly increased in acceleration speed as compared to CG. The result also reveals that increase in acceleration speed is significantly more for HVBTG as compared to LVBTG.

**Discussion of Findings**

The result of present study was that acceleration speed has increased significantly for high velocity ballistic training group and low velocity ballistic training group as compared to control group. However, the result of the present study also reveals that increase in acceleration speed significantly more for high velocity ballistic training group than low velocity ballistic training group. It is inferred that endurance training has produced statistically significant effect on acceleration speed. However, acceleration speed also improved significantly after ballistic training protocol.

High-velocity and low-load training is related to an ability to produce force quickly and has implications for activities of daily living as well as athletic endeavors. High velocity exercise
results in specific high velocity adaptations and should be employed when attempting to increase high speed movements. Sports that require athletes to sprint faster or jump higher may benefit from assisted training that mimics sport specific movement speeds. Since maximizing speed is one of the most desired goals for fitness and performance, implementing innovative high-speed methods within a training program can aid in maximizing performance. In addition, short duration training is effective for the acute adaptation of neural factors, which results in an acute increase in performance in the absence of muscular hypertrophy.

Speed requires greater power of repetitive movements since ballistic training demands higher velocity of repetitive movement and speed development is greater for ballistic training. Hence it is natural that ballistic training shows greater increase only in acceleration speed. Olsen and Hopkins, (2003) conducted a study on effect of attempted ballistic training on force and speed of movements and concluded that the training group significantly improved in speed when compared to the control group. Kotzamanidis et al., (2005) also found significant improvements in 30m sprint following a heavy strength training program, but also highlighted the lack of skill transfer which the argued that since sprinting involves high levels of interlimb coordination, there is little or no learned effect from the gym-based strength training. Comfort et al., (2012) also showed similar improvements in 20m-sprint performance following an eight-week period of strength training. However, his study was held in the pre-season. Plyometric and ballistic type training methods are commonly used for improving sprint and potentially soccer playing performance. Chelly et al (2009). Structural and neuromuscular adaptations such as increase in muscle fibre diameter, specifically type I (11%), type IIa (10%) and hybrid type IIa/x (15%) have been observed together with an increased neural drive following plyometric and ballistic training. Subjects within the BT group showed percentage improvements (1.00%) in sprint timings. Delecluse (1995), the weighted ballistic actions included in the training could possibly have resulted in higher production of explosive ground reaction forces resulting in better sprint times. Ronnestad et al., (2008) established that a seven- week combined plyometric and strength-training program resulted in overall improvements in acceleration, peak running velocity and 40m-sprint time. Thomas et al., (2009) suggested that it could be due to the longer duration of the training and the added weight when performing a CMJ. Since the ability to generate muscular power in the lower limbs, specifically the ankle, knee and hip extensors is highly correlated to short-distance sprint times.
Harris et al., (2008) have found that in 50 m sprint, significant improvements from pre- to mid-training (-1 %, p = 0.02), as well as from mid- to post-training (-1.9 %, p < 0.001) were observed in his study. Numerous studies found significant improvements in sprint time after jump squat training over distances ranging from 5 to 40 m, as well as in an agility test. Loturco et al., (2015) have examined the effect of jump squat training at the distance of 50 m. It is difficult to determine whether these changes are due to improvements in the early (acceleration) or later (maximum speed) phase of running because no split times were measured in the study. Nevertheless, given the abundance of improved sprint performance over short distances (i.e., 5-30m), the data seem to suggest that the greatest improvements occurred during the acceleration phase of sprint running. Furthermore, in the study by Sleivert and Taingahue (2004) a relationship between maximal concentric jump power and sprint acceleration was found. This is perhaps logical since longer ground contact time is needed during the acceleration phase of running compared to maximum running speed. The results of these studies support and prove that high and low velocity ballistic training has significant effect on acceleration speed among novice college athletes.

**Conclusion**

There was a significant improvement in acceleration speed on high velocity ballistic training group and low velocity ballistic training group as compared to control group. However, the result of the present study also reveals that increase in acceleration speed, significantly more for high velocity ballistic training group than low velocity ballistic training group among novice college athletes.
REFERENCES


