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POWER DEVELOPMENT IN THE STARTING PHASE OF SPEED RUNNING

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ABSTRACT. Introduction: Short distance running is part of the maximum intensity cycling exercises, consisting of combined efforts, each step being performed as a result of a complete impulse, characterized by covering a distance in a shorter time. **Objective:** This study aims to follow the development of power for the start in short distance speed trials. **Material and method**: A 26-year-old male athlete, who has been practicing athletics for 14 years, participated in the study, based on the 100-meter flat sprint. The pre-test was performed before the preparation period, the intermediate test after one, two and three mesocycles (months) and the final test after the fourth mesocycle (after 4 months). The evaluations followed the strength with which 4 exercises were performed (deadlift, clean, power clean and squat) of 6 repetitions each. At the same time, the length of the distance covered in the first three steps from the start was followed. During the four mesocycles, the athlete participated in specific strength development training. **Results:** Following the training program for the development of lower limb power, execution speed and lower limb strength, statistically significant results were observed in 2 of the 4 exercises performed in the evaluations. Regarding the jumped step starting from the two different positions, an evolution was observed reaching from the length of 5.24m to 6.44m in the first variant, and from 5.31m to 5.93m in the second variant. In both cases the execution time of the three steps increased, reaching the value of 1.85s, respectively 1.49s. **Conclusions:** Following the results obtained in the five evaluations, we notice that the training program was developed efficiently and that the results improved in most of the evaluation tests.

Keywords*: speed, power, start, athletics.*

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Introduction

In many sports, success is largely determined by the strength of the athlete's lower limbs. In many events such as jumping, throwing, running and others, the athlete must use his strength with the greatest intensity and in the shortest possible time. In sports where the emphasis is on improving speed and strength, increasing power will help the athlete improve their performance (Adams et al 1992; Dawes & Lentz, 2012). Lower limb strength plays a very important role in athletic performance and the methods for its development are diverse, including plyometric exercises, resistance training and complex training (May et al 2010).

The speed tests are predominantly anaerobic tests, alactacyd for the 100m and 4x100m relay and lactacyd for the 200m and 400m (including hurdles tests). The mechanical efficiency is dependent on the frequency of the steps and the thrust, i.e. the length of the steps. The neuropsychic and neuromuscular systems are very much in demand, which makes these tests considered extremely hard: blood pH sometimes below 7, the body making great adaptive efforts to maintain the osmotic, acid-base and hydro-mineral balance.

Short-distance sprinting is characterized by covering a distance in a short period of time and is part of the maximum intensity cycling exercises, their efforts being combined, each step performed being the response of a complete impulse. It can be divided into four phases, namely: the start, the launch from the start, the run along the course and the finish.

By start we mean all the positions and movements performed in order to start the run with maximum efficiency. Positions and movements are subordinate to the goal of the run (speed or endurance) and the start commands. In sprints, the bottom start is used.

Sprinting is an effort made by the athlete, characterized by covering a certain distance at maximum speed. The sprint standard is the 100 meters, considered one of the most appreciated and watched events at the Olympic Games.

The start is one of the most important phases of the short-distance sprint, being the moment when the maximum speed must be reached as quickly as possible using both the speed of execution and the force with which the impulse is made. The two motor qualities put together, speed and strength, give the athlete power.

A 2010 study aimed to investigate the bilateral deficit (ie, the sum of the maximal force of an exercise performed unilaterally as greater than the maximal force of an exercise performed bilaterally) analyzed in the jump squat exercise in elite sprinters and to observe the relationship between bilateral

deficit and start performance in sprint trials. The authors stated that athletes with greater bilateral impairment produced a lower total starting force impulse and lower velocity, determinants of performance in the 60m and 100m sprint events (Bračič et al 2010).

Objective

In this study the objective is to analyze the starting power in the lower limbs for the start phase of the speed trials over the distance of 100m. A higher level of lower limb power is hypothesized to provide better performance at the start of the sprint tests.

Material and method

A male athlete born in 1995, who has been practicing performance athletics since 2008, participated in the study, often participating in the 100m event. He is 1.75 meters tall and weighs 77 kilograms, a body mass index of 25.16. In the 14 years he collected numerous national medals, both in individual events and in relay events.

The subject was tested to track the development of power, speed and strength by performing a set of specific exercises to measure lower limb power. The follow-up period of the training program was four mesocycles.

Before the training period, an initial test was performed, at an interval of one mesocycle (one month) a number of 3 intermediate tests were performed and after the fourth mesocycle (after 4 months) the final test was performed.

During the evaluations, 4 exercises were performed for the assessment of power, strength and speed (deadlift, clean, power clean and squat) of 6 repetitions each, with each test being performed in the same order. Through the maximum repetition method, the maximum capacity of the athlete was determined in order to find out the load with which the exercises will be performed during the evaluations, this being a percentage of 70% of the maximum number of kilograms that the subject could overcome in the execution of the respective exercise. The loads with which the exercises were performed were the following: deadlift with 50kg, clean with 40kg, power clean with 40kg and squats with 70kg.

At the same time, the distance traveled in the first three steps from the start was measured. The distance covered by three steps was measured starting with the feet at the same level and with one foot in front of the other. The time in which the three steps are completed in the two starting variants was also timed.

During the four months, the athlete participated in specific strength training sessions. Initially, the exercises were performed to develop muscle resistance by performing a number of 12-20 repetitions, but with an intensity of 50%-70% of the athlete's maximum capacity, with a 3-4 minute break between sets. In training mesocycles 2, 3 and 4, the objective was to develop strength by performing a number of 6-8 repetitions, with an intensity of 70%-80% of the maximum capacity, having a break of 3-4 minutes.

The Beast device was used to track the athlete's progress. This is a small device (20x19x40 mm), weighing approximately 38 grams and equipped with a magnetic plate to be attached to the metal bar with which the athlete works. The machine provides data on the power measured in watts, the force measured in Newtons, and the speed measured in meters per second with which the exercises are performed (Beast Sensors, 2014).

Centralization of the data after the tests was carried out with the help of an Excel file. The device was observed to provide for each exercise, information regarding the average for each individual repetition as well as the maximum value captured in that repetition.

At the end of the five tests, in the excel table with all the data, I calculated the average of the values of the 6 repetitions performed that day for each individual exercise, both for the average value/repetition and for the average of the maximum values. The standard deviation was calculated at each evaluation to track the constant with which the 6 repetitions of the respective testing were performed.

Statistical significance (p) was calculated using the T-test to see what percentage of the results obtained were due to chance, comparing the results of the initial test with the results of the last test performed.

Results

Changes were observed regarding all the exercises performed by the subject following the tests performed. The data was divided by each exercise separately to be able to follow the evolution from one test to another.

Deadlift with 50kg:

The results of the five power assessments of the 50-kilogram deadlift. In the initial test, the average of the 6 repetitions was 561 W, in the intermediate tests, 563 W, 670 W, 672 W, and in the final test, 734 W. At the same time, the standard deviation in each test was followed, evolving as follows: 115, 82, 122, 133, 125. The T-test result for the comparison of the initial evaluation with the third testing was p=0.004, and for the comparison with the final testing p=0.03.

In the deadlift exercise, measurements were made regarding the execution speed of the 6 repetitions. The results of the five evaluations evolved gradually, having the following values: 1.04, 1.05, 1.21, 1.14, 1.31. The data has statistical significance with a p value of 0.03, although the standard deviation remained roughly around 0.18.

The force with which the deadlift exercise was performed did not show a constant evolution throughout the four mesocycles, as a result of the initial testing the average value of the six repetitions was 538 N, in the second testing it was 534, in the fourth testing it went up to the value of 580, to decrease to the value of 558 in the last test. The six repetitions were performed fairly constant in the tests 1, 2, 3 and 5, except for the 4th test where the standard deviation had value of 60, which is 3.4 times higher compared to the other ratings. Comparing the initial testing with the final testing, a value of p=0.06 was obtained, this being statistically insignificant.

The data obtained in the deadlift exercise showed that the speed developed during the training period, the results being statistically significant, in contrast to the execution force where the results have no statistical significance. However, in terms of power, an evolution was observed from one test to another.

Clean with 40kg:

Following the analysis of the results of the 40 kg clean exercise in terms of the power of the lower limbs, an upward evolution was observed after the first two mesocycles, and then a downward slope of the results was observed, at the final testing obtaining a lower value than in the first test, from a value of 575 W initially to a value of 546 W at the end. During the five assessments the six repetitions were performed more and more consistently, reaching from a standard deviation of 103 to a value of 59. Balancing the initial and final testing it was observed that the data are not statistically significant (p=0 ,16).

As with the power rating, the average values curve is upward with a peak at the third test and then a downward slope. From an average running speed of 1.30 m/s in the initial testing, it reached the value of 1.40 m/s in the third testing, and in the end obtaining a lower value than in the first evaluation, the running speed being 1.25 m/s. The execution was more and more consistent, with the standard deviation getting smaller and smaller. However, the results were not statistically significant, yielding a p-value of 0.19.

The strength in the execution of the clean exercise remained approximately constant throughout the five evaluations, with the results fluctuating between 430 N and 445 N. Following the application of the T-test, a p=0.16 was obtained, which means that there are 16% chances of the results being random, the value being statistically insignificant.

The results of the three monitored parameters were categorized as not being statistically significant, which means that the poorer results obtained in the last two tests are due to an incorrect execution technique or the fact that muscle fatigue intervened.

Power clean with 40kg:

Following the statistical analysis of the results in terms of power in the power clean exercise, it was observed that the data are insignificant (p=0.08). Initially, the average value of the six repetitions was 556 W, at the second test it seemed that the results were following a favorable course (592 W), then, at test number 3, the value returned close to the initial one (557 W). In the last two tests it was noticed that the results dropped a lot, obtaining values of 518 W and 527 W. The standard deviation had very close values in test 1, 2 and 4 having the values of 30, 36 and 33. In the test of third, a larger standard deviation was observed, which means that the repetitions were not performed as consistently. At the final testing, the lowest value of the standard deviation was obtained (19), representing a greater constancy in the execution of the exercise.

According to the results of the five tests, the execution speed follows a curve similar to that of the previously described power parameter, obtaining the following average values: 1.28, 1.35, 1.26, 1.19 and 1.21. Comparing the first test with the last test it was observed that there is more than 5% chance that the data was obtained by chance.

Regarding the strength, according to the results illustrated it could be observed that the values remained approximately constant, oscillating between 435 N and 439 N. Applying the T test on these data a statistically insignificant value was obtained (p=0.44).

Squat with 70kg:

During the preparation period it can be seen that the power with which the squatting exercise was performed increased a lot until the third test, reaching from a value of 422 W to a value of 676 W, then until the end it decreased to the value of 592 W. It was also observed that the standard deviation gradually decreased from the value of 168 to 23 at the final testing, meaning that the repetitions were performed more and more consistently regardless of the power exerted by the lower limbs. Applying the T-test, it was proven that the data is highly statistically significant, with the p value of 0.02.

Regarding the execution speed of the squats, it was observed that the values increased and remained approximately constant in the last tests, the squat being initially performed with a speed of 0.57 m/s, so that in the final testing it reached be executed with an average speed of 0.78 m/s. The repetitions were

performed more and more consistently, with the standard deviation decreasing from the value of 0.22 to the value of 0.3. The p-value was 0.03, which is statistically significant.

Similar to the pattern observed for power and speed parameters, the mean force value increased and the standard deviation value gradually decreased. Comparing the initial assessment with the final assessment, it was observed that the results are statistically significant (p=0.03).

As for the step jumped starting from the two different positions, an evolution was observed reaching from the length of 5.24m to 6.44m in the first variant, and from 5.31m to 5.93m in the second variant. In both cases the execution time of the three steps increased, reaching the value of 1.85s and 1.49s, respectively.

Discussions

Strength training, Slimani says, is an effective training regimen for improving muscle strength in young athletes. However, "age" and "gender" had effects on height with respect to the jump squat exercise. This finding may be explained by maturation and sex-specific physiological characteristics. In the same paper it was specified that longer periods of strength training (≥8 weeks) are more effective in inducing better results in the jump squat exercise in both child and adolescent athletes compared to short-term interventions (<8 weeks) (Slimani et al, 2018).

Gacesa carried out a study whose purpose was to investigate the variable values of power in athletes involved in different sports disciplines and to compare these values in relation to the specific requirements of each sport discipline. He observed that the highest strength values were measured in athletes who practiced volleyball and basketball, the results being statistically significant (Gacesa et al, 2009).

Meng Ni, in a 2016 study stated that a 3-month muscle strength program significantly reduced bradykinesia and increased muscle strength and power in elderly patients with Parkinson's disease. Strength training is an effective way of training to improve physical function and quality of life for people with Parkinson's disease (Ni et al, 2016).

The results of a study carried out in 2010, suggest that the distances covered in the one-legged jump and the one-legged triple jump exercises are good indicators for predicting performance in the first 10 m after the start (Habibi, et al., 2010).

Force application technique is a determinant of performance in the 100 m, which is not the case for the maximum force that subjects can apply on the ground. The orientation of the maximum force applied to the running surface at the time of acceleration is more important than its amount (Morin et al 2011).

According to Slawinski, to get the best possible start, performance sprinters designed their center of gravity as close to the finish line as possible. He stated that greater muscle strength and better arm coordination lead athletes to have a greater rate of power development and to impart greater center-of-gravity velocity (Slawinski, et al., 2010).

One study compared ballistic exercise training to strength training with weights. Both forms of training have been shown to be effective in the short term, but in the long term, weight training provides better results by improving maximal strength (Cormie et al 2010).

A study carried out on 12 sportswomen analyzed the neuromuscular activation of the lower limbs performing the jumping squat exercise, with different rest periods. The results showed that statistically significant improvements ($p=0.001$) were achieved after the 30 second, 1 minute, 2 minute and 3 minute breaks. After a 5-minute break, the results were statistically insignificant ($p=0.43$). We can say that we get better results in terms of the strength of the lower limbs if they perform the exercises with breaks of maximum 3 minutes (Satavand et al 2021).

Conclusions

In conclusion, the training program for developing the power of the lower limbs was 50% effective, obtaining statistically significant results in 2 of the 4 exercises performed during the evaluations.

After the training, the performance improved in the first three steps from the start, which means that the training is effective for the development of power in the start phase of speed tests on short distances.

Specific training for power development is very important, but the perfecting of the execution technique should not be neglected in order to obtain the best results with the least effort, i.e. to be as efficient as possible.

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