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Timişoara Physical Education and Rehabilitation Journal

10.2478/tperj-2022-0003

# Power development analysis for the start phase of 100m

**Nicolae-Adrian JURJIU[1], Tiberiu PUTA[2], Ciprian GLAZER[3]**

**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 mesocycle (one month) and the final test after the second mesocycle (after 2 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 two mesocycles, the athlete participated in specific strength development training.
*Results:* After the two-month training period, statistically significant ($p<0,05$) improvements were observed in 3 of the 4 exercises, with clean improving from 575 W to 626 W, with deadlift from 560 W to 670 W , and at squat from 422 W it reached 676 W. Regarding the result obtained at power clean, an improvement was observed from 556 W to 557 W, statistically insignificant ($p = 0.48$). At the triple step, there were improvements both when starting with both feet at the same level and when starting with one foot before.
*Conclusions:* Following the results obtained in the three evaluations, we notice that the training program was developed efficiently and that the results improved in all the evaluation tests.

***Key words**: speed, power, start, athletics*

**Rezumat**

*Introducere:* Alergarea de viteză pe distanţă scurtă face parte din exerciţiile ciclice de intensitate maximală, constituită din eforturi combinate, fiecare pas efectuându-se ca urmare a unei impulsii complete, caracterizată prin parcurgerea unei distanţe într-un interval de timp cât mai scurt.
*Obiectiv:* Acest studiu îşi propune să urmărească dezvoltarea puterii pentru startul în probele de viteză pe distanţă scurtă.
*Material si metodă:* În studiu a participat un atlet de gen masculin, cu vârsta de 26 de ani, care practică atletismul de 14 ani, având ca probă de bază alergarea de viteză pe distanţa de 100 metri plat. Pretestarea s-a efectuat înaintea perioadei de pregătire, testarea intermediară după un mezociclu (o lună) şi testarea finală după cel de-al doilea mezociclu (după 2 luni). La evaluări s-a urmărit puterea cu care s-au executat 4 exerciţii (îndreptări, pus la piept cu bara, cu bara pus la piept cu genuflexiune şi genuflexiuni) a câte 6 repetări fiecare. În acelaşi timp s-a urmărit şi lungimea distanţei parcurse în primii trei paşi de la start. Pe parcursul celor doua mezocicluri, atletul a participat la antrenamente specifice de dezvoltare a puterii.
*Rezultate:* După perioada de două luni de pregătire s-au observat îmbunătăţiri semnificativ statistice ($p<0,05$) la 3 din cele 4 exerciţii, la pus la piept cu bara îmbunătăţindu-se de la 575 W la 626 W, la îndreptări de la valoarea de 560 W a ajuns la valoarea de 670 W, iar la genuflexiuni de la 422 W s-a ajuns la 676 W. În ceea ce priveşte rezultatul obţinut la exerciţiul de pus la piept cu bara cu genuflexiune s-a observat o îmbunătăţire de la 556 W la 557 W, nesemnificativ statistic ($p=0,48$). La pasul de triplu s-au înregistrat îmbunătăţiri atât la plecarea cu ambele picioare de la acelaşi nivel, cât şi la plecare cu un picior mai înainte.
*Concluzii:* În urma rezultatelor obţinute la cele trei evaluări, observăm că programul de antrenament a fost elaborat eficient şi că rezultatele s-au îmbunătăţit la toate probele de evaluare.

***Cuvinte cheie**: : viteză, putere, start, atletism*

[1] Research assistant, Faculty of Physical Education and Sport, West University Timisoara, Romania, *e-mail: nicolae.jurjiu@e-uvt.ro*
[2] Lect.univ.Dr, Faculty of Physical Education and Sport, West University Timisoara, Romania
[3] Phd student, Faculty of Physical Education and Sport, West University Timisoara, Romania

**Introduction**

Success in many sports depends largely on the explosive power of the lower limbs that the athlete has. In jumping, throwing, running and other events, the athlete must be able to use his strength in the shortest possible time and with the greatest possible intensity. An increase in strength gives the athlete the opportunity to improve performance in sports that aim to improve the relationship between speed and strength (Adams et al., 1992) (Daweset al., 2012). Strength in the lower limbs is an important component of athletic performance and there are several methods used for development, including plyometric exercises, resistance training and complex training (May et al., 2010).

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 short time.

One of the most important phases of short-distance running is the start, the moment when you need to reach the maximum speed as quickly as possible, using both the speed of the execution of the movements and the force with which the impulse is achieved at the level soil. The two motor qualities, speed and strength, combined, actually give the athlete strength.

A study conducted in 2010 aimed to investigate the bilateral deficit (ie the maximum voluntary force of a task performed bilaterally as less than the sum of the maximum voluntary force of unilaterally performed tasks), measured in the counter-movement jump exercises with elite sprinters and to analyze the relationship between the bilateral deficit and the performance at the start in the sprint events. The authors concluded that sprinters with a higher bilateral deficiency produced a lower total force impulse on the blockstart and a lower block speed, factors that determine the overall performance of the 60 m and 100 m sprint trials. (Bračič et al., 2010).

**Aim**

This study aims to develop and analyze the force and velocity of the lower limbs for the start phase of the short distance speed tests. It is assumed that a higher level of lower limb power provides better efficiency in the start phase of sprint trials.

**Material and method**

The study involved a 26-year-old male athlete who has been practicing athletics for 14 years, based on 100-meter flat speed running. He is 175 centimeters tall and weighs 77 kilograms. During the 14 years since he started this sport, he has won numerous national medals, both in the individual events and in the relay events.

In order to follow the development of power, the subject underwent tests that consist of a set of specific exercises to measure the power of the lower limbs. The period chosen to monitor the effectiveness of the training program was two mesocycles.

The pre-test was performed before the preparation period, the intermediate test after one mesocycle (one month) and the final test after the second mesocycle (after 2 months).

The evaluations followed the power with which 4 exercises were performed (deadlift, clean, power clean and squat) of 6 repetitions each, these being performed in this order at each test. In order to determine the load with which the exercises will be performed during the evaluations, we had to find out what is the maximum capacity of the subject by the method of maximum repetition (RM). Subsequently, the load that we can use during the evaluations was identified, this being a percentage of 70% of 1 RM, from the maximum number of kilograms that the subject was able to overcome in performing the respective exercise. In our case we reached the following values: deadlift with 50kg, clean with 40kg, power clean with 40kg and squats with 70kg.

At the same time, the length of the distance covered in the first three steps from the start was followed. In the first phase, the distance covered was measured by three jumping steps starting from the stand position, with the feet at the same level. The next assessment was performed to determine the distance traveled by three jumped steps starting from the top start position, one foot in front of the other. For the two starting variants, the time in which the three steps are executed was also timed.

During the two mesocycles, the athlete participated in specific power development training. In the first period, exercises were used mainly for the development of muscular endurance, but also of muscular hypertrophy by performing a higher number of repetitions (12-20 repetitions), but with a

lower intensity, which means 50% -70% of the maximum capacity of the subject, the rest time being 3-4 minutes. In the second part of the training, the subject underwent a training program that aimed mainly at developing power by performing a smaller number of repetitions (6-8 repetitions), but with an intensity of 70% -80% of maximum capacity. , the rest time is also 3-4 minutes.

The data used in this study were collected using the Beast device. This is a small device, 20x19x40 mm, which weighs about 38 grams and is equipped with a magnetic portion so that it can be positioned on the bar with which the athlete works. The device provides information on the power measured in watts, the force measured in Newton, and the speed measured in meters per second at which the exercises are performed (Beast Sensor, 2014).




Fig 1. Beast device

After testing, the data was centralized by extracting the Beast device manufacturers from their own platform and sorting them into an Excel file. It has been observed that for each exercise, the software of this device provides information on the average for each repetition as well as the maximum value captured in that repetition.

At the end of the three evaluations, in the table where we gathered all the data, for each exercise, we calculated the average of the values of the 6 repetitions performed on that day, both for the average value / repetition and the average of the maximum values. At the same time, the standard deviation was calculated for each evaluation in order to follow the constancy of performing the 6 repetitions during the respective test.

Finally, using the T test, the statistical significance (p) was followed to see what the percentage is for the results obtained to be random, comparing the results from the pretest with the results of the intermediate test, but also the results from the pretest with those from the test. final after the two mesocycles.

**Results**

Following the evaluations, changes were observed in all the exercises performed by the subject. The data were divided each exercise so that progress could be tracked from one test to another.

| Nr. Repetare | 14.12.2021 | 18.01.2022 | 01.03.2022 |
|---|---|---|---|
| | mean power (W) | mean power (W) | mean power (W) |
| 1 | 329 | 428 | 452 |
| 2 | 634 | 506 | 756 |
| 3 | 615 | 579 | 730 |
| 4 | 612 | 630 | 659 |
| 5 | 595 | 651 | 630 |
| 6 | 580 | 583 | 794 |

Fig 2. Results of deadlift

The table above shows the results of the three assessments in the 50 kg deadlift exercise. At the initial test, the average of the 6 repetitions was 561 W, at the intermediate test 563 W, and at the final test 670. At the same time, the standard deviation of each test was followed, evolving as follows: 115, 82, 122. The result of the T test for the comparison of the initial evaluation with the intermediate one it was p = 0.47, and for the comparison with the final test p = 0.004.

| Nr. Repetare | 14.12.2021 | 18.01.2022 | 01.03.2022 |
|---|---|---|---|
| | mean power (W) | mean power (W) | mean power (W) |
| 1 | 381 | 447 | 508 |
| 2 | 587 | 608 | 613 |
| 3 | 611 | 661 | 600 |
| 4 | 563 | 615 | 679 |
| 5 | 678 | 582 | 672 |
| 6 | 629 | 569 | 687 |

Fig 3. Results of clean exercice

Regarding the clean exercise, the data show that in the first phase an average value of 575 W was obtained, in the second test a value of 580 W, and in the last test the value of 626.5 W. Standard deviation had a downward trajectory as follows: 103, 73, 68. Comparing the first two tests the value of p was 0.42, and comparing the first with the last test, the value of p was 0.04.

| Nr. Repetare | 14.12.2021 | 18.01.2022 | 01.03.2022 |
|---|---|---|---|
| | mean power (W) | mean power (W) | mean power (W) |
| 1 | 503 | 556 | 452 |
| 2 | 563 | 550 | 536 |
| 3 | 587 | 597 | 471 |
| 4 | 566 | 638 | 571 |
| 5 | 577 | 586 | 620 |
| 6 | 541 | 628 | 693 |

Fig 4. Results of power clean exercise

The results for the three assessments in the power clean exercise were averaged as follows: 556 W, 592 W, and 557 W. In this case, the standard deviation was upward, gradually increasing from 30 to 36, to finally take the value of 91. After the first mesocycle a positive statistical significance was observed (p = 0.038), but in the end, after collecting the last results the p became 0.49.

| Nr. Repetare | 14.12.2021 | 18.01.2022 | 01.03.2022 |
|---|---|---|---|
| | mean power (W) | mean power (W) | mean power (W) |
| 1 | 83 | 526 | 702 |
| 2 | 510 | 581 | 779 |
| 3 | 452 | 486 | 625 |
| 4 | 517 | 500 | 637 |
| 5 | 492 | 514 | 654 |
| 6 | 478 | 541 | 660 |

Fig 5. Results of squat

The average of the three evaluations had an ascending slope increasing from one evaluation to another: 422 W, 525 W, 676 W. The standard deviation fluctuated, being initially 168, then 34, and at the final testing taking the value of 57. After the first period of preparation, the statistical significance gave the value of p of 0.099, and at the end after performing all measurements, p became 0.01.

Regarding the jumped step starting from the two different positions, an evolution was observed, reaching from the length of 5.24m to 5.51m in the first variant, and from 5.31m to 5.78m in the second variant. In both cases the execution time of the three steps increased, reaching the value of 1.61s.

**Discussions**

In the 50kg deadlift exercise, after performing the three evaluations, it was observed that the results are statistically significant (p = 0.004), the average of the 6 repetitions increasing from one test to another, especially from the intermediate to the with a difference of 107 W. The standard deviation initially decreased, but later increased to 122, which means that in the intermediate test the repetitions were performed with a more constant power, and at the last test the values began to easily move away from their average.

Both the clean and the squat exercise showed a gradual increase in the average of the 6 repetitions. The standard deviation decreased from one assessment to another in terms of clean exercise, and a slight increase in squat exercise was observed at the last assessment compared to the intermediate test. In both exercises the improvement in results is statistically significant (p <0.05).

The only exercise where the results after the last evaluation are not statistically significant (p = 0.49) is the power clean exercise. This result may be due to improper execution of the last test.

Power training, according to Slimani, is an effective training for improving the muscular power of young athletes. However, "age" and "gender" had effects on height in terms of the squat jumping exercise. This finding can be explained by maturation and gender-specific physiological characteristics. In the same paper, it was specified that longer power training periods (≥8 weeks) are more effective in inducing better results in squat exercise in both child and adolescent athletes compared to short-term interventions (<8 weeks) (Slimani et al., 2018).

Gacesa conducted a study aimed at investigating the variable values of power in athletes involved in different sports and to compare these values in relation to the specific requirements of each sport. He noted that the highest values of power were measured in athletes who practiced volleyball and basketball, the results being statistically significant. (Gacesa et al., 2009).

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

The results of a study conducted in 2010 suggest that the distances performed in the jumping exercises on one leg and the triple jump on one leg, are good indicators for predicting performance in the first 10 m from the start (Habibi et al., 2010).

The force application technique is a determinant of performance in the 100 m test, which does not apply

to the maximum force that subjects can apply to the ground. The orientation of the maximum force applied to the running surface at the time of acceleration is more important than its quantity (Morin et al., 2011).

In Slawinski's opinion, in order to have a good start, the performance sprinters designed the center of gravity as close as possible to the finish line. He said that greater muscle strength and better coordination of the arms cause athletes to have a higher rate of development of strength and to impress a higher speed on the center of gravity (Slawinski et al., 2010)

One study compared ballistic exercise training with weight training. It has been shown that in the short term both forms of training are effective, while in the long run, strength training with weights provides better results by improving maximum strength. (Cormie et al., 2010).

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

## Conclusions

We can conclude that the training program for the development of lower limb power was effective, obtaining statistically significant results in 3 of the 4 exercises performed in the evaluations.

Following the training period, a longer distance was observed in the first three steps from the start, which means that the training program is effective in developing the power in the start phase of the short distance speed tests.

In addition to the specific training program for power development, it is also very important to follow and improve the execution technique in order to obtain the best possible results with the least possible effort, to be as efficient as possible.

## References


1. Adams, K., O'Shea, J. P., O'Shea, K. L., & Climstein, M. (1992). The effect of six weeks of squat, plyometric and squat-plyometric training on power production. *Journal of applied sport science research*, 6 (1), 36-41.
2. Beast Sensors. (2014). Retrieved from https://thisisbeast.com/ on May, 24, 2021.
3. Bračič, M., Supej, M., Peharec, S., Bačič, P., & Čoh, M. (2010). An investigation of the influence of bilateral deficit on the counter-movement jump performance in elite sprinters. *Kinesiology*, 73-81.
4. Cormie, P., McGuigan, M. R., & Newton, R. U. (2010). Adaptations in athletic performance after ballistic power versus strength training. *Med Sci Sports Exerc*, 42 (8), 1582-1598.
5. Dawes, J., & Lentz, D. (2012). Methods of developing power to improve acceleration for the non-track athlete. *Strength & Conditioning Journal*, 44-51.
6. Gacesa, J. Z., Barak, O. F., & Grujic, N. G. (2009). Maximal anaerobic power test in athletes of different sport disciplines. *The Journal of Strength & Conditioning Research*, 751-755.
7. Habibi, A., Shabani, M., Rahimi, E., Fatemi, R., Najafi, A., Analoei, H., & Hosseini, M. (2010). Relationship between jump test results and acceleration phase of sprint performance in national and regional 100 m sprinters. *Journal of Human Kinetics*, 29-35.
8. May, C. A., Cipriani, D., & Lorenz, K. A. (2010). Power development through complex training for the division I collegiate athlete. *Strength & Conditioning Journal*, 30-43.
9. Morin, J. B., Edouard, P., & Samozino, P. (2011). Technical ability of force application as a determinant factor of sprint performance. *Med Sci Sports Exerc*, 1680-1688.
10. Ni, M., Signorile, J. F., Balachandran, A., & Potiaumpai, M. (2016). Power training induced change in bradykinesia and muscle power in Parkinson's disease. *Parkinsonism & related disorders*, 37-44.
11. Satavand, S., Nikbakt, M., & Habibi, A. (2021). Effect of post-activation potentiation in different time intervals on the explosive power of athlete girls. *Journal of Practical Studies of Biosciences in Sport*, 46-57.
12. Slawinski, J., Bonnefoy, A., Levêque, J. M., Ontanon, G., Riquet, A., Dumas, R., & Chèze, L. (2010). Kinematic and kinetic comparisons of elite and well-trained sprinters during sprint start. *The Journal of Strength & Conditioning Research*, 896-905.
13. Slimani, M., Paravlic, A., & Granacher, U. (2018). A meta-analysis to determine strength training related dose-response relationships for lower-limb muscle power development in young athletes. *Frontiers in physiology*, 1155.