Bulletin of the *Transilvania* University of Braşov
Series IX: Sciences of Human Kinetics • Vol. 12(61) No. 1 – 2019
https://doi.org/10.31926/but.shk.2019.12.61.21

BIOMECHANICAL DETAILS REGARDING THE EFFICIENCY OF START IN SPRINTING EVENTS

Tomina Dana PETRESCU[1]

Abstract: *My research is based on a study on start efficiency in sprinting events to highlight some details that would harness the athlete's potential at the start. The research was based on film sequences of some athletes ranked in the first three at the Indoor National Championship. Compareing their evolutions, we intend to present a personal approach of start, experimented and used by us in competitions with unexpectedly good results and that we present through the "key" sequences of an athlete filmed, which progressed in five weeks from 7.64 s on 60 m to 7.01 s - second place at the Indoor National Championship for jrs I. To illustrate the differences between our vision and what is currently being practiced in athletic competitions, we try to reason through a comparative study of the evolutions of three component subjects of the National Athletics Team, based on the dynamic parameters of the running steps.*

Key words: *start, contact time, impulse angle.*

1. Introduction

The stagnation and even the regression of the performances of the Romanian athletes in the shortest Olympic sprint test -100 m, urges us to ask our question - why?

Given the complexity of the athletic event, the factors that depend on the results in competitions in the sprint event, among which the most important may be physical training in all aspects, technical training, psychological training, theoretical and tactical training.

It is known that the value of performance in sprint events is particularly influenced by force and, implicitly, power as a form of

[1] Secondary School Nr 4, Bistrița, Romania.

manifestation.

The question is how and in what report is it with the other factors of training?

The premise: We started from the idea that the level of power development is decisive in achieving superior performance at 100 m, but although our sprinters have now reached values of muscle strength that in some cases exceed three times their own body mass, our sprinter's performances are even less valuable than those 20 to 30 years ago, with all this body mass.

Hypothesis**:** If the problem of the capacity of force is solved even more than the recommendations of the specialists, we believe that the way to make departures from a technical point of view can substantially improve the final results in sprint tests.

Methods**.** To conduct the study, we used the OPTOJUMP system and program to determine the parameters of the running steps for the three subjects we studied, different in terms of physical and strength potential. ll the values that we obtained were presented in the tables in the following paper.

2. Comparative Study of the Parameters of the Steps

Determined on the interpretations of the records with OPTOJUMP, the values are specific to the approach of departure style from the block-start of each subject from our research.

2.1. Contact time (Table 1)

Even if the first two have values closely related of performances (subject 2 - 6.77sec occupant of the second place, and subject 1- 6.78sec place III at the Indoor National Championship for seniors,) one can observe somehow significant differences between the values for contact on the first 5 steps.

Contact time Table 1

	Sub. 1	Sub. 2	Sub. 3
1			
2	0,583	0,436	0,534
3	0,679	0,508	0,622
4	0,607	0,454	0,556
5	0,683	0,477	0,584
Minimum	(#2) 0,580	(#2) 0,436	(#2) 0,534
Maximum	(#3) 0679	(#3) 0,414	(#3) 0,622
Avg	0,607	0,469	0,574
Std dev	0,042	0,035	0,038
CV	6,8%	6,2%	6,6%

If we make a comparison of the first two subjects that are specialized sprinters, the third subject, which is specialized in athletic combined tests, had values that are totally between the values of the first two subjects.

Observing the values of the standard deviation and the coefficient of variability, it is observed that they reveal an evolution that can be considered as high efficiency.

2.2. Flight phase time (Table 2)

The duration of the flight phases shows an approximately similar evolution of the contact times as an almost logical reaction of the parameters determined in the previous phase of ground contact.

Flight phase time Table 2

	Sub. 1	Sub. 2	Sub. 3
1	0,498	0,304	0,456
2	0,390	0,291	0,356
3	0,507	0,379	0,464
4	0,502	0,378	0,460
5	0,493	0,369	0,452
Minimum	(#2) 0,390	(#2) 0,291	(#2) 0,356
Maximum	(#3) 0,507	(#3) 0,379	(#3) 0,464
Avg	0,503	0,355	0,438
Std dev	0,049	0,037	0,046
CV	11,7%	8,5%	10,5%

Regarding the homogeneity of the flight phases on the first steps, although the standard deviations are almost identical to those of the contact phase made in the first step, instead the coefficient of variability, in two cases passed 10 units and only subject 2, remained below 10 units.

2.3. The height flight phase trajectory (Table 3)

Another parameter with a rather high effect on performance is the flight phase height which, compared, shows similar evolutions between the three subjects as in the previous phases. The lowest trajectory was performed by subject 2 in Step 1 with 12.7cm in Step 2, followed by subject 3, 15.5cm, and subject 1 with 17.5 cm, while the highest value was made in Step 3 by subject 1 with 28.7cm.

Already entering into a more complex analysis of the standard deviation is found that if the figures are below 5 units, the coefficient of variation increased to around 20 units.

The height flight phase trajectory Table 3

	Sub. 1	**Sub. 2**	**Sub. 3**
1	27,8	20,8	25,5
2	17,0	12,7	15,5
3	28,8	26,4	26,4
4	28,3	20,8	25,9
5	27,3	20,6	25,0
Minimum	(#2) 17,5	(#2)12,7	(#2) 15,5
Maximum	(#3) 28,8	(#3) 26,4	(#3) 26,4
Avg	25,7	23,7	23,7
Std dev	4,9	4,6	4,6
CV	21,6%	6,4%	19,4%

2.4. The power (Table 4)

Determination developed power flow on each step, is meant to substantiate the values discussed above, and to which all other values are reported for each of these parameters.

Power developed Table 4

	Sub. 1	**Sub. 2**	**Sub. 3**
1			
2	15,96	13,26	14,26
3	21,29	15,92	19,48
4	22,27	16,47	20,21
5	21,07	16,22	19,28
Minimum	(#2) 15,96	(#2) 13,26	(#2) 14,26
Maximum	(#4) 22,21	(#4) 16,47	(#4) 20,21
Avg	20.15	15,47	18,31
Std dev	2,72	2,72	2,72
CV	16,2%	12,6%	14,9%

The greatest power was developed in the first step of subject 1 with a value of 15.96 Watts, nearly 1.5 watts more than subject 3 and almost 2.5 watts more than subject 2 Regarding the homogeneity of the power evolution, a standard deviation with values below 3 units and the coefficient of variability with values of 16.2% is found at subject 1.

2.5. The running pace (Table 5)

The running pace has one of the most balanced developments regarding the first steps start running low, with values close to running speed requirements of the first steps to start.

The running pace Table 5

	Sub. 1	Sub. 2	Sub. 3
1			
2	15,96	13,26	14,26
3	21,29	15,92	19,48
4	22,27	16,47	20,21
5	21,07	16,22	19,28
Minimum	(#2) 15,96	(#2) 13,26	(#2) 14,26
Maximum	(#4) 22,21	(#4) 16,47	(#4) 20,21
Avg	20.15	15,47	18,31
Std dev	2,72	2,72	2,72
CV	16,2%	12,6%	14,9%

With values between 0.09 and 0.11 of the standard deviation and the coefficient of variation below 0.5, the running rate shows an almost maximum homogeneity.

These data highlight the fact that the final result in a sprint test depends on many other factors, more important than the reaction time and the parameters of the running step, as can be seen from the comparison of the parameters made by subject 1 and subject 2, which are diametrically opposed, at the end of the 60 m race, the difference was only 0.01 seconds.

Referring to the short times taken by our subjects, it highlights a higher frequency with shorter steps and a shorter flight phase – perhaps lower at the athlete subject 2, while at subject 1 values of running step parameters are somehow higher, which highlights a higher power rate than his colleague.

2.6. Step length (Table 6)

We analyzed each time related to the dynamics of steps running phases, we calculated length increase for each leg and the total length of the distance for all steps of the run.

The value of the arithmetic average (Avg) of the length of the five running steps determined for the entire distance has values between 416 ± 214cm and 388 ± 233cm with a coefficient of variability ranging between CV 59.6% and 47, 8%, which in statistical terms means almost maximum homogeneity.

Step length Table 6

	Sub. 1	Sub. 2	Sub. 3
Right Leg	123±1 CV 1,4%	134±1 CV 1,1%	132+21 CV 16,1%
Left Leg	277±568 CV 91,7%	304±276 CV 68,2%	331 ±295 CV 89,2%
Lg. pas	416±214 CV 59,6%	446±194 CV 47,8%	388±233 CV 59,9%

3. Speed Parameters

Speed of the execution as the essential condition of running speed depends on the ability to coordinate the alternation between contraction and central inhibition, and relaxation control across the entire muscular system.

Therefore, it is also said that one of the conditions of increasing the frequency of the step is the control of relaxation.

The execution speed, synonymous with the frequency of steps per unit time, is one of the main parameters of speeding. In this regard they have been registered for the right leg stroke 6,21sec values ± 0,00sec, which was determined a coefficient of variation CV0,0% in the case of the subject 1, which means that maximum homogeneity, which can not be said about the other two subjects.

On the left leg, maximum homogeneity was reached by subject 3 for which time was determined with values around the values of 4.98sec ± 0.00sec, which gave CV 0.00%.

Speed parameters Table 7

	Sub. 1	Sub. 2	Sub. 3
Right Leg	6,21±0,0 CV 0,0%	6,48±0,13 CV 12,3%	5,49±0,98 CV 17,9%
Left Leg	6.32±1,51 CV 31,9%	6,67±1,52 CV 20,4%	4,98±0,00 CV 00.0%
Dev. Standard	6.43±1,21 CV 33,2%	6.78±1.09 CV 23,4%	5.32±0,75 CV 14,1%

4. Discussions

Following this analysis, it can be said that - there is some sort of personalization of the way the first steps are taken after leaving from the block-start, but that does not cause significant differences between the evolutions of the three subjects studied by us.

When we say personalization, we have referred to the attempt to capitalize each of the subjects on those aspects of the training he best masters, and not to "adapt the biomechanics" of the start - to his own physical particularities (biomechanics are respected! - requests adjust.)

The values shown in the above tables reinforce the belief that not the maximum force value is important in the lower start departures in the sprint samples, but approaching a position that allows the runner to make the most of his strength by performing efficiently in terms of the dynamics of the first running steps, along with the most economical energy demand.

5. Conclusions

Taking into account the above, we can state the following conclusions:

1. For the departure from the block-start, it is more important to adopt a position specific to the "ready" command, which allows for a greater inertia to the body mass at the time of detachment from the start block.
2. Dynamics of steps on the first 10 m from start (for acceleration) 2. Dynamics of steps on the first 10 m from start (for acceleration) must allow the rapid increase of the maximum inertia of the body mass in the conditions of the passage as fast as possible to the speed step.
3. The rapid increase in body mass inertia depends on the adoption of optimal angles to allow maximum use of the potential of the athlete.
4. Positioning the hands perpendicular to the ground at the starting line at equal distances (left-right) relative to the perpendicular to the front foot line, reduce to the maximum the deviation of the impulse vectors.

References

1. Bezodis, N. E.: *Biomechanical investigations of sprint start technique and performance*. University of Bath, 2009.
2. *Biomechanics Sprint Start Analysis;* https://www.youtube.com/watch?v=Iooapls-8Ys. Accessed on 20.03.2018.
3. Bondoc-Ionescu, D., Târgoveţ, A., Cosac, G., Damian, R., Oancea, B., Ungur, R., Ciulea, L.: *Individualized proprioceptive training based on analysts' information in the sport-specific motor activity*. Braşov, Editura Universităţii Transilvania din Braşov, 2017.
4. Miller, C., Quievre, J., Gajer, B.: *From biomechanical analysis to the development of sprinter's specific muscle strength.* INSEP - laboratory of biomechanics and physiology.
5. Gagea, A: *Analytical biomechanics.* Ed. Char. Dounias & Co., Greece, 2006, p.100.
6. Korchemny, R.: O nouă concepţie asupra startului la sprint şi antrenamentul alergării (A new concept on sprint start and running training). *New Studies in Athletics*; Great Britain, 1992.
7. Michiyoshi, Ac., Ito, A., Suzuki, M.: The men`s 100 m - *The Scientific Research Project at the III World Champions in Athletics;* by IAAF, 1992, p. 45-72.
8. Petrescu, T., Petrescu, T.D.: *Permissive and restrictive aspects of velocity development.* Giurgiu, Publishing House for Sport, 2016, p. 64- 65, 68.
9. *Slow mo Analyse of Best Starting Block Technique - Asafa Powell;* https://www.youtube.com/watch?v=9IwHjF_CiYc. Accessed on 20.03.2018.

10. *Speed Science. Acceleration* https://www.youtube.com/watch?v= GZaneGIbiSI analize starthttps://www.youtube.com/watch?v=v2_t7R1KcPM. Accessed on 20.03.2018.