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**Original Article**

# The relationship between the kinematic parameters of the block start and the first step speed in female representatives of the Slovak Republic in athletic sprints

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**Abstract**
This article points to the kinematic parameters of the block start in the position "Set" and in the "First step after the shot" between female representatives of the Slovak Republic in athletics. The tested subjects were 22 finalists of the SR Championship for adults, juniors, and teenagers. Nonparametric procedures were selected based on the assessment of the normality of the distribution of the files. We use descriptive statistics to present the parameters. The relationships between the kinematic variables and the first step speed are assessed by Spearman's correlation coefficient " $r^s$". The non-parametric algorithm CHAID - Chi-squared Automatic Interaction Detector and Trees was used for the construction of decision trees. This technique can be used to predict, classify and detect interactions between variables. We present the regression parameters for the models. The results were processed in MS Excel and IBM SPSS Modeler. Our findings and conclusions are formulated on the basis of objective and logical evaluation of the obtained results. Using the tree method, kinematic indicators were selected that showed high closeness to the first step speed. The slope of the back block (angle 1), the height of the pelvis (length 5) and the distance of the first block to the starting line (length 1) entered the regression model of women at the attention command to the first step speed. The first step speed after the shot was determined by the distance of the first step from the first block (length 4) and the angle in the knee joint of the front leg (angle 10). The obtained results are closely related to the specificity of the deliberate selection of sets of sprinters, to which their current performance or block start technical level. Since these are representatives of the Slovak Republic, the obtained results can be used as a guideline for the technical improvement of the block start of other athletes.
**Key Words: Block start, Kinematic Analysis, Step Speed, Representatives.**

## Introduction

The block start is one of the most crucial parts of the sprint, but despite its importance and the constantly changing technology, equipment, surface and footwear, there are still many questions about how the correct mechanics of this start looks like. In our work, we focus primarily on the angle analysis in the starting positions at the command "Watch out" and at the "First step after the shot". Since the run from the blocks and the acceleration itself after the start are the most important phases of the sprint, technical correctness is essential and this occurs if the sprinter is able to perform the maximum acceleration in the minimum time. The shorter the track distance, the more important technical correctness is. The angle view is individual for each sprinter, as individual sprinters have different somatic parameters, such as body height, weight, proportion of body fat, musculature and body structure, which is characterized by a certain somatotype (Aerenhouts et al., 2012; Cavedon et al., 2019; Pavlovič et al. 2022). It is therefore not surprising that over the years there have been many biomechanical studies that have yielded some very important information for both theoretical and practical use for elite sprinters (Hoster, 1981; Mero, Luhtanen & Komi, 1983; Moravec, Ružička, Susanka, Dostál & Nosek, 1988; Mero, 1988; Coppenolle, Delecluse, Goris, Bohets & Eynde, 1989; Coppenolle, Delecluse, Goris, Seagrave & Kraayenhof, 1990; Guissard, Duchatenau & Hainaut, 1992; Delecluse, Coppenolle, Diels & Goris, 1992; Korchemny, 1992; Schot & Knutzen, 1992; McClements, Sanders & Gander, 1996). After analyzing thousands of athletes over many years and working with actual interactive training sessions on the track with elite athletes, a single "Golden position" has been determined as a benchmark for assessing overall launch mechanics (Mann & Murphy, 2018; Slawinski et al., 2010). This position is represented by the position during the first step. According to Bezodis, Willwacher, and Sala (2019), this position is among the most significant measures of performance when running out of blocks. In our work, we focus on this position and how this position can affect the run itself, or even the performance in the 60-meter run of representatives of the Slovak Republic in the women's category. As stated by Mann and Murphy (2018), in order for this technical correctness to occur at the start, it is necessary to keep all segments of the body in the front part in the "Set" position and at the same time minimize any action that occurs in the back part of the body (Otsuka et al., 2015). This means that


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approximately 70% of the body's weight is weighed on the front part, that is, on the hands. During the first step, the height of the pelvis, the angle of the ankle with the ground, the angle of the torso and the lower part of the leg during take-off are the most critical. In the "First step after the shot" position, we raise the pelvis to a position where we are in a so-called half-crouched position, while we continue to try to raise the body to an upright position so that the movement is performed as optimally as possible with maximum acceleration. This, in combination with keeping the body balanced on one leg in a short time, makes the most difficult step in the whole sprint performance (Valamatos et al., 2022), because if this step is not performed correctly, not only the power is lost, but it also negatively affects the rest of the start and the very transition to maximum speed (Nagahara & Ohsima, 2019; Coh, Peharec, & Bacic, 2007; Čoh, Peharec, Bačić, & Mackala, 2017; Wibowo, R., Natawidjaja, M. A. R., Nugraha, E., Budiman, D., Rusdiana, A., & Sumarno, G., 2021). An interesting fact is that many studies show that during the run, the toe should be guided just above the surface of the ground and not rubbed against the surface. This movement does not create excessive friction, which would make it impossible to take off in a minimum time with maximum acceleration. Our work explains which angles or lengths play a key role in the performance. Many indicators agree with various authors who have dealt with this issue. We believe that our findings will help to further improve young sprinters, both to enhance technical accuracy and boost performances in sprinting disciplines.

**Goal**

The aim of the work is to point out the level of kinematic parameters of the block start in the "Set" position and during the "First step after the shot" in female representatives of the Slovak Republic in athletics. The secondary goal is to point out the causal relationships and the determination of the first step speed from the kinematic indicators in the "Set" and "First step after the shot" positions.

**Methods**

The test group consisted of 22 athletes from the MSR adult, junior and adolescent finals. The average age of the ensemble is 20.36 years. These are the elite sprinters of the Slovak Republic, who have been involved in sprinting and block starts for a long time.

The measurements were taken at the Slovak Indoor Championships for women, juniors and teenagers. Each subject was monitored while preparing for their discipline, in this case the 60 meters and the 60 meters hurdling. Runs were carried out no later than 3 minutes before the actual start. The layout of the starting blocks was individually set according to the preferences of the sprinters.

Video recordings were taken on an iPhone 6s at the level of the starting line in a distance of 5 meters (Ciacci et al, 2016) and at 65 cm heaight. Kinematic indicators were evaluated in two positions. The first position was at the starting position "Set" and the second position was at "First step after the shot" (Figure 1 and 2). This is a 2D analysis for which we used the Kinovea program. The choice of angles was determined on the basis of scientific and professional publications.

Nonparametric procedures were selected based on an assessment of the normality of the distribution of the files. Data were processed in MS Excel and IBM SPSS Modeler.

Relationships between kinematic parameters of a block start and sports performance at 60 m, or the first step speed were assessed by Spearman's correlation coefficient "$r^{s}$". We assess the statistical significance of relationships at the 5% and 1% significance levels.

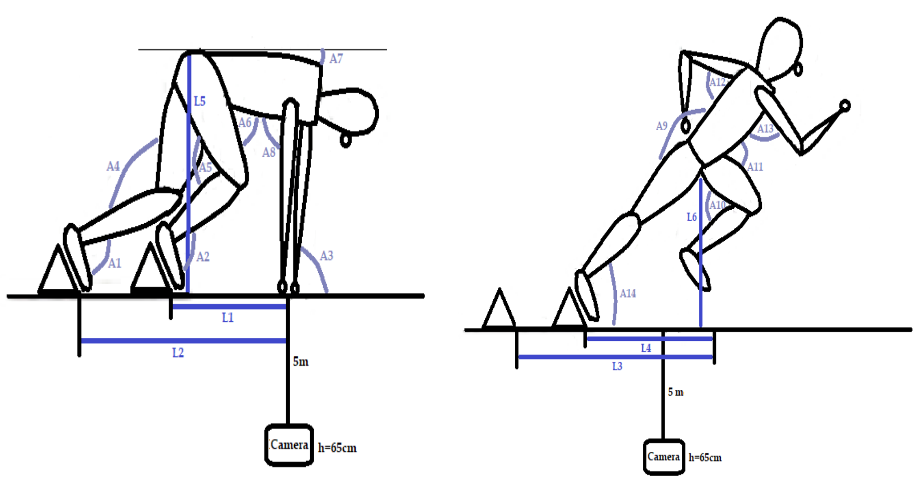


**Figure 1 and 2** Monitored kinematic parameters in the starting position "Set" and during the "First step after the shot" (Explanations: L - length, A - angle, h - height)

The non-parametric algorithm CHAID - Chi-squared Automatic Interaction Detector and Trees (Breiman et al., 1994) was used for the construction of binary trees. This technique can be used to predict, classify and detect interactions between variables.

The advantage of the CHAID technique is that it allows better summarization, interpretation and presentation of binary trees. CHAID creates trees that tend to be "wider". In each step of the analysis, it searches for one predictor that has the greatest influence on the dependent variable categories (Camp & Slattery, 2002). However, CHAID may not always find an optimal distribution for the variables. As soon as it finds out that all remaining categories are statistically insignificant, it stops merging categories.

**Table 1** Characteristics of kinematic indicators in the "Set" position, "in the first step after the shot" in the group of women.

| | | | M | SD | Min | Max |
|---|---|---|---|---|---|---|
| | Abbrev. | First step (s) | 0.41 | 0.04 | 0.35 | 0.50 |
| | | First step speed ($m.s^{-1}$) | 3.40 | 0.35 | 2.60 | 4.01 |
| Starting position "Set“ | Lenght 1 | Length of the front block to the line (cm) | 52.31 | 11.53 | 36.51 | 89.50 |
| | Lenght 2 | Length of the rear block to the line (cm) | 72.82 | 11.64 | 43.34 | 86.55 |
| | Lenght 3 | Length of the first step from the back block (cm) | 137.30 | 11.95 | 114.68 | 157.92 |
| | Lenght 5 | Length height of pelvic position (cm) | 95.88 | 7.07 | 84.00 | 111.32 |
| | Angle 1 | Angle of the rear lower limb in the ankle joint (º) | 89.80 | 8.53 | 74.60 | 107.00 |
| | Angle 2 | Angle of the front lower limb in the ankle joint (º) | 84.28 | 7.34 | 72.40 | 98.20 |
| | Angle 3 | Angle of the hands to the mat (º) | 90.07 | 8.29 | 75.60 | 111.60 |
| | Angle 4 | Angle of the hind limb in the knee joint (º) | 107.80 | 11.94 | 86.10 | 129.30 |
| | Angle 5 | Angle of the front limb in the knee joint (º) | 90.97 | 8.50 | 73.90 | 107.40 |
| | Angle 6 | Angle between front limb and trunk (º) | 31.08 | 6.09 | 21.40 | 42.90 |
| | Angle 7 | Angle of the torso perpendicular to the mat (º) | 34.69 | 6.92 | 20.70 | 46.20 |
| | Angle 8 | Angle between arms and torso (º) | 102.34 | 9.12 | 84.30 | 116.40 |
| The first step after the shot | Lenght 4 | Length of the first step from the front block (cm) | 111.64 | 12.22 | 86.65 | 137.60 |
| | Lenght 6 | Length of pelvic position during the first step (cm) | 80.85 | 8.95 | 64.83 | 97.33 |
| | Angle 9 | Angle between lower limbs and torso (º) | 142.89 | 15.30 | 103.80 | 167.90 |
| | Angle 10 | Angle of the front leg in the knee joint (º) | 106.06 | 10.54 | 87.40 | 128.00 |
| | Angle 11 | Angle of the torso with the front limb (º) | 88.03 | 9.14 | 74.70 | 106.20 |
| | Angle 12 | Angle of rear upper limb to trunk (º) | 28.66 | 12.57 | 3.80 | 60.30 |
| | Angle 13 | Angle of front upper limb to trunk (º) | 46.37 | 15.62 | 23.00 | 77.10 |
| | Angle 14 | Angle of the body to the mat (º) | 40.93 | 3.35 | 33.80 | 46.00 |

When analyzing the results, we therefore rely on pruned regression trees with prediction branches, which contain logically interpretable causal relationships of variables and prediction possibilities within the scope of achieving the best sports performance in the 60 m run, or more precisely, the first step speed.

Regression parameters such as Linear Correlation R, Standard Deviation SD, Mean Absolute Error MAE were also given for the models; Mean Error ME.

The interpretation of the results and conclusions was formulated on the basis of objective and logical evaluation.

**Results**

By non-parametric correlation analysis of kinematic indicators in the starting position "Set" and in the "First step after the shot" to the sports performance of women in the 60 m run and first step speed (table 2), we found rare and significant connections.

Statistically significant relationships of kinematic indicators in the starting position "Set" are found only for the **first step speed** at the length of the first step from the back block (Length 3, $r^s = 0.556$, $p < 0.01$) and the angle of the back lower limb in the ankle joint (Angle 1, $r^s = -0.518$, $p < 0.05$).

In our test group, the length of the first step from the front block was correlated with the first step speed **in the first step** after the shot (Length 4, $r^s = 0.592$, $p < 0.01$;). In this position, the height of the center of gravity during the first step correlated with the 60 m run (Length 6, $r^s = 0.445$, $p < 0.05$).

Using the CHAID method, the kinematic indicators in the position "Set" and "First step after the shot" were selected, which showed high closeness with the performance in the 60 m run and the speed of the first step.

**Table 2** Correlation of women's sports performance in the 60 m run, first step speed and kinematic indicators in the position "Set" and in the "First step after the shot" (Spearman's correlation coefficient $r^s$, $p<0.05$)

| | | Woman (n = 22) | | | |
|---|---|---|---|---|---|
| | | Run 60 m | | First step speed | |
| | | $r^s$ | p | $r^s$ | p |
| Starting position "Set“ | Lenght 1 | 0.170 | 0.449 | 0.368 | 0.092 |
| | Lenght 2 | -0.008 | 0.970 | 0.249 | 0.263 |
| | Lenght 3 | 0.112 | 0.620 | **0.556** | **0.007** |
| | Lenght 5 | 0.418 | 0.053 | 0.227 | 0.311 |
| | Angle 1 | 0.146 | 0.516 | **-0.518** | **0.014** |
| | Angle 2 | 0.090 | 0.689 | -0.172 | 0.444 |
| | Angle 3 | 0.156 | 0.488 | 0.016 | 0.944 |
| | Angle 4 | -0.253 | 0.257 | 0.055 | 0.809 |
| | Angle 5 | 0.077 | 0.734 | 0.015 | 0.946 |
| | Angle 6 | 0.096 | 0.672 | -0.062 | 0.783 |
| | Angle 7 | -0.024 | 0.915 | -0.386 | 0.076 |
| | Angle 8 | 0.230 | 0.302 | -0.422 | 0.051 |
| The first step after the shot | Lenght 4 | 0.056 | 0.805 | **0.592** | **0.004** |
| | Lenght 6 | **0.445** | **0.038** | 0.096 | 0.671 |
| | Angle 9 | -0.077 | 0.734 | 0.287 | 0.195 |
| | Angle 10 | 0.297 | 0.180 | 0.027 | 0.907 |
| | Angle 11 | -0.134 | 0.553 | -0.137 | 0.542 |
| | Angle 12 | 0.108 | 0.631 | -0.275 | 0.216 |
| | Angle 13 | -0.002 | 0.992 | 0.058 | 0.797 |
| | Angle 14 | 0.399 | 0.066 | -0.170 | 0.449 |

In Figure 3 and 4, we can see them in the cut classification trees. The performances are predicted at the speed of the first step in $m.s^{-1}$.

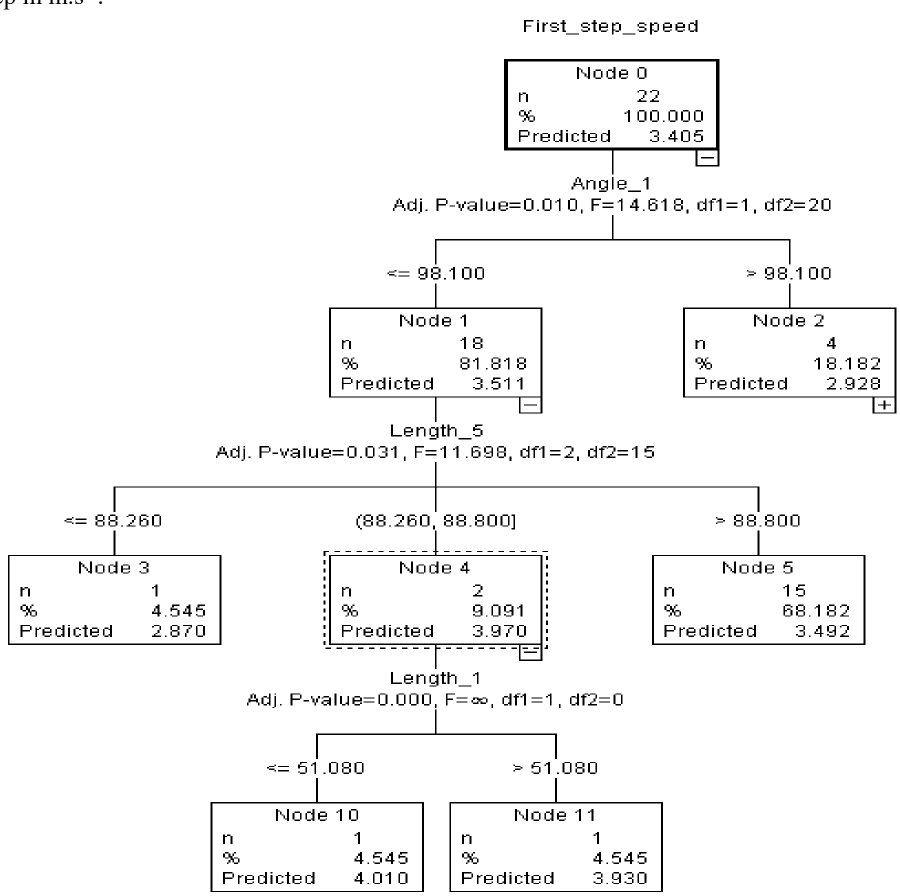


**Figure 3** Regression tree of selected kinematic parameters of women in the "Set" position to the first step speed by the CHAID method (R: 0.893, SD: 0.159, MAE: 0.119, ME: 0.000)

**Table 3** Prediction model of kinematic parameters of women in the "Set" position for the first step speed by the CHAID method

| Node | Criterion | Prediction | Effect | N |
|---|---|---|---|---|
| 1 | Angle 1 <= 98.1 | 3.511 | 0.106 | 18 |
| 4 | Lenght 5 > 88.26 and <= 88.8 | 3.97 | 0.459 | 2 |
| 10 | Lenght 1 <= 51.08 | 4.01 | 0.04 | 1 |
| 11 | Lenght 1 > 51.08 | 3.93 | -0.04 | 1 |
| 3 | Lenght 5 <= 88.26 | 2.87 | -0.641 | 1 |
| 5 | Lenght 5 > 88.8 | 3.492 | -0.019 | 15 |

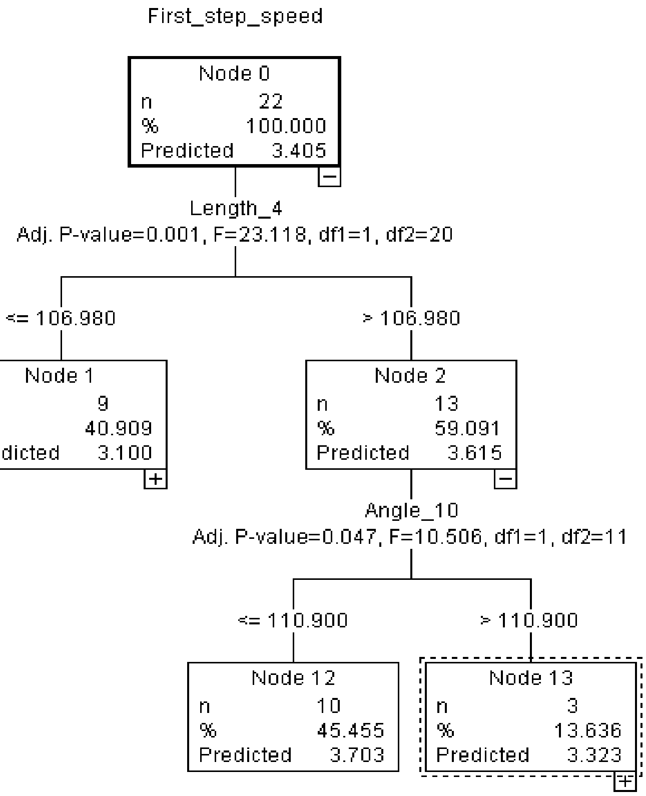


**Figure 4** Regression tree of selected kinematic parameters of women in positions "First step after shot" to first step speed by CHAID method (R: 0.932, SD: 0.128, MAE: 0.065, ME: 0.000)

**Table 4** Prediction model of women's kinematic parameters in the position "First step after the shot" to the first step speed by the CHAID method

| Node | Criterion | Prediction | Effect | N |
|---|---|---|---|---|
| 1 | Lenght 4 <= 106.98 | 3.100 | -0.305 | 9 |
| 2 | Lenght 4 > 106.98 | 3.613 | 0.211 | 13 |
| 12 | Angle 10 <= 110.9 | 3.703 | 0.088 | 10 |
| 13 | Angle 10 > 110.9 | 3.323 | -0.292 | 3 |

The prediction branch of the regression tree (Figure 3, Table 3) for "First step speed" in the position "Set" consists of 3 kinematic parameters. The constructed model shows a very high closeness of R = 0.893 to indicators of the angle of the posterior lower limb in the ankle joint (Angle 1, F = 14.618; p = 0.01), the position of the pelvis in the "Set" position (Length 5, F = 11.698; p = 0.031) and the distance of the front block to the starting line (Length 1, F = ∞; p < 0.01). Variability of the first step speed from 3.405 to 4.010 $m.s^{-1}$ can be achieved in women by setting the slope of the first block <= 98.10° (Node 1, 3.511 $m.s^{-1}$), the position of the pelvis at the "watch" command from 88, 26 to 88.8 cm (Node 4, 3.970 $m.s^{-1}$) and the distance of the first block to the starting line <= 51.08 cm (Node 10, 4.010 $m.s^{-1}$). The remaining variants predict a lower first step speed.

In the "First step after the shot" positions, first step speed was determined by the 2nd kinematic indicators (Figure 4, Table 4). The constructed model shows that R = 0.932 is closely linked to the indicators length of the first step from the front block (Length 4, F = 23.118, p = 0.01) and angle in the knee joint of the front leg (Angle 10, F = 10.506, p = 0.047) .

Variability of the first step speed from 3.405 to 3.703 $m.s^{-1}$ can be achieved in women at a distance of the first step from the front block > 106.98 cm (Node 2, 3.615 $m.s^{-1}$) and at an angle in the knee joint of the front leg < = 110.90° (Node 12, 3.703 $m.s^{-1}$). The remaining variants of the regression tree predict a lower step speed.

**Discussion**

By analyzing the results, the parameters were selected that significantly influence the performance in the 60-meter run, or the first step speed of the female representatives of the Slovak Republic. Among the determinants of sports performance, the first step speed, angle 1 (the angle of the hind limb in the ankle joint), length 5 (the height of the pelvis) and length 1 (the length of the front block to the line), length 4 (the length of the first step from the front block) and angle 10 (angle of the front leg in the knee joint). All angles and lengths in the monitored group are largely influenced by the setting of the blocks, which is linked to sports specialization (sprints and hurdles), current performance and, last but not least, to the somatic indicators of the female sprinters themselves (Aerenhouts et al. 2012, Cavedon et al. 2019 , Pavlovic et al. 2022). Authors Mann & Murphy (2018) claim that a good tactics is to place the front block so that when the athlete places the front knee on the ground, it is about 3 centimeters from the starting line. After determining the front block, the back block should be approximately 170% of this distance. So if the front block is 56 cm then the back block should be approximately 94 cm (56 x 1.70) from the line. This position places the torso and legs in the best power position to produce maximum explosive power on the blocks. If we average the values of all sprinters, we arrive at the results for the front block of 52.31 cm and for the back block of 72.82 cm. If we were to follow this formula and leave the value of the front block in it, the back block should be at a distance of 88.93 cm. Conversely, in order to keep the value of the back block, the front block should be at a distance of 42.83 cm. In this case, the results may be distorted and do not show whether individual sprinters use this aid or not, but if we take the sprinters individually, it will tell us more. For example, our fastest female sprinter, according to her measured values, uses this tool, which points to the fact that she has the correct block setting according to the findings of Mann & Murphy (2018). On the other hand, our slowest sprinter does not use this kind of aid and it is reflected in her weaker performance. It follows that we can agree with the authors, since even in our results one of the most important indicators predicting higher performance is length 1, which would not be able to be adjusted correctly without a properly adjusted back block. Angle 1 (the angle of the rear limb in the ankle joint) is supposed to provide the sprinter with such a position that, from the back block, the ankle goes just above the ground, while the limb is stretched to the point where the toe can be just above the surface. This is also the procedure for the second leg, i.e. the first step from the blocks. As with both limbs, when taking off to fully extend the limb, we try to pull the toe just above the ground, not rub it on the ground. That creates unnecessary friction (Mann & Murphy 2018). The back block is largely involved in the amount of horizontal speed or force. According to Bezodis et al. (2019) and his analysis of different sprinters, there is no influence of the usual slope of the block, i.e. the angle in the ankle joint. However, our regression analysis says that this angle plays an important role. On the other hand, he claims that if the difference between the angles of the limbs is in the range of 10-15°, it can positively affect the first step speed. If we are to take our average values of angle 1, they represent the number 89.9°. At angle 2 it is 84.28. It follows that the deviations of the sprinters represent a difference of only 5.62°, which is not even close to the values according to Bezodis et al. (2019), who clearly showed in his results that it increases the speed. From this we can assume that if these standard deviations were observed, the speed of our female sprinters could be higher.

Many other authors such as Nosek & Valter (2010), Ciacci et al. (2016), Slawinski et al. (2010) pay attention to the angles that, according to them, positively influence the sprinter's performance itself. They do not include any of our resulting angles or lengths among the angles which, according to them, predict better performance. These are the angles between the thigh of the front leg and the foreleg (angle 5), the angle of the back leg and the foreleg (angle 4), the angle between the thigh of the front leg and the torso (angle 6), and the take-off angle, i.e. the angle between the sprinter and the mat during standing in the command " First step after the shot" (angle 14). According to the authors Nosek & Valter (2010), one of the key angles already at the "First step after the shot" command is the take-off angle and the rebound angle. At narrow position, this display represents 10°/35°, at medium 13°/40° and at wide 17°/45°. We focused primarily on the angle of reflection, which in our opinion is one of the most important, even if our program did not select this particular angle. We believe that it is caused by the variability of the group from the point of view of sports specialization, sports performance and somatic indicators. The averaged values of our sprinters represent a reflection angle of 40.93°, which, according to this assumption, means that a wide setting of the blocks is rather preferred, but since the number is borderline, we can assume that the second most preferred is the middle setting of the blocks. We cannot prove whether this is really true, as we do not know the somatic parameters of female sprinters and as many angles deviate from the standards of recommended angles according to Nosek & Valter (2010), apparently not all female sprinters have correctly adjusted blocks for their parameters, explosiveness and strength. One of the lengths selected by the program is length 5 (height of the pelvic position). Authors such as Čoh et al. (1998), Aerenhousts et al. (2012) showed much lower values in their research than in our group of female sprinters. While in their set it is 57 cm, our average value is up to 95.88 cm. On the other hand, if we consider the first step speed of the women in their group, they reached an average speed of 3.33 m/s, while our average value was 3.40 m/s, and our fastest sprinter even reached a speed of 4.01 m /s. Regression analysis shows that shorter first step times are achieved by more dynamic types of sprinters, or sprinters achieving faster times in 60-meter runs. It is known that these parameters can be changed due to some forms of strength training (Brughelli & Cronin, 2007). Based on our results, we can assume that it is not necessary that the height of the pelvic position should be as low as possible, although other studies such as Bezodis et al. (2015), Čoh et al. (1998), Slawinski et al. (2010) claim the opposite. According to Mann & Murphy (2018), the combination of horizontal velocity and vertical velocity in stride speed with ground contact time is much more important in running than hip height. Most trainers try to minimize the vertical force, but if we combine it appropriately with the horizontal force, in the combined mechanism of the arms and legs, we can consider the execution of the start successful. However, lower vertical velocity actually allows for higher step speed and efficient acceleration (Hunter et al. 2004). Considering these very findings regarding the set height of the pelvic position, it would seem reasonable to say that it is unlikely that there is a single optimal set position (Bezodis et al. 2015), precisely because of the number of factors, among which individual strength may play the biggest role. If we go from the "Watch out" position to the "First step after the shot" position, we are aware of the angle 10 (the angle of the front leg in the knee joint during the first step), which is largely influenced by length 4. This angle is largely limited by the hip flexion, which can be manifested through a less inclined pelvis forward and weakened or shortened muscles of the psoas muscles (Bezodis et al. 2019). Similar to the length of the first step, when the distance is shortened, at an angle of 10, the angle does not appear to such an extent that it would help the sprinter to move smoothly into acceleration. If it is too large, the sprinter steps on the entire foot, which does not allow him to take over the flexibility of the ankle. On the other hand, if the angle is too small, it will cause the sprinter the instability of the limb, which can put him into discomfort and thus make further wrong steps. The values of our group of female sprinters represent 106.06°. The ideal values for the correct extension of the limb should be in the range of 90°-100° Čoh et al. (1998), Aerenhousts et al. (2012). According to the average value, our sprinters are slightly above the idea of ideal. Length 4 (the length of the first step from the front block is to a large extent individual, it depends on the somatic parameters of female sprinters and their height. Therefore, there is no strictly given distance. According to the research of Yadav & Reddy (2017), the length of the first step was 1.463 meters at 45/60 degrees block and considered the second best step length to be 1.46 meters at 75/90 degree blocks. A medium block setting was preferred for all female sprinters, as with most of our female sprinters. If we compare our average value of 111.64, we find out that the distances of our sprinters are significantly shorter, as even our sprinter with the longest stride did not exceed or come close to the results of the above group. From this we can conclude that our female sprinters are not using their 100% potential and their flexibility in the lumbar area deserves more attention. According to Yadav & Reddy (2017), a longer stride led to a higher linear speed at take-off but, on the contrary, increased the time to run out of the blocks, which did not hurt the final part of the performance. We can conclude that if the observed sprinters were able to extend their stride by a few centimeters and perform it at a similar, if not faster, speed during the start, it would also be reflected in a better transition to acceleration.

Thanks to the findings provided by the regression analysis or the comparison of the results with other researches, we can agree that our best female sprinters, even if they meet the limits for top events, so we can consider them above average, they might or might not achieve better performances if they lengthened, shortened, enlarged or reduced individual lengths or angles according to the standards we provided you in our work.

**Conclusions**

In our work, we were able to specify the kinematic parameters of the block start of Slovak female representatives in athletics and compare them with the parameters of foreign male and female sprinters presented in professional and scientific literature.

Secondarily, we managed to point out the causal relationships between the kinematic indicators of a block start and the first step speed.

Statistically significant correlations of kinematic indicators were demonstrated in women in the starting position "Set" to the first step speed at the length of the first step from the back block and to the angle of the back lower limb in the ankle joint. In women, the length of the first step from the front block was also correlated with the the first step speed.

Among the predictors of the first step speed in the starting position "Set", the slope of the first block, the height of the hips at the attention command and the distance of the first block prevailed. The predictors of the first step speed in the "First step after the shot" position in women were the length of the first step from the front block and the angle in the knee joint of the front leg.

Setting blocks, the correct starting position of the athletes at the command "Set" or the technique of running out of blocks significantly influence the first step speed, acceleration and subsequently sports performance in short-distance running.

The acquired knowledge once again points to the justification of a block start in the structure of sports performance in short-distance running. Systematic improvement of the block start is necessary in the long-term sports training of athletes and in individual stages (Nosek & Valter, 2000). Formation and improvement of the start itself, or sprinting from the blocks depends on all the sprinting skills and abilities that have been practiced in parallel in sports training and have created a solid neuromuscular model. We are aware that the effective development of special sprinting abilities in sprints requires long-term formation of specific training stimuli. Measuring the load dynamics is based on respecting the uniqueness of the individual adaptation mechanisms of the athlete's organism, and this happens either in the short or long term.

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