THE EFFECT OF GENDER AND ANTHROPOMETRICAL PARAMETERS ON DYNAMIC OF SPRINT START AMONG YOUNG ELITE SPRINTERS

Saeed Ilbeigi[1], Mohamad Yousefi[2], Alireza Nasirzadeh[3], Bart Van Gheluwe[4]
Faculty of Physical Education, University of Birjand, Iran[1, 2, 3]
Dept. of Biometry and Biomechanics, Vrije Universiteit Brussel, Belgium[4]

The sprint start is a complex motor task characterized by large forces exerted in the horizontal direction and ability to generate these forces in a short time. The aim of this research was to study the starting block dynamics parameters during the sprint start. Moreover, gender and anthropometrical measurements as corrected thigh girth (CTG), corrected calf girth (CCG) and total body skeletal muscle mass (SMM) were used to evaluate their influence on the dynamic variables. The results presented a significant influence of age, gender and other anthropometrical parameters on block velocity, block acceleration, force and impulse, where the older boys displayed significantly higher block variable values than girls. Moreover, the maximum force exerted on the front and rear legs were the best predictor for the mean velocity of the sprinters.

KEY WORDS*:* Sprint start, block variables, anthropometric parameters, gender.

INTRODUCTION: An efficient start can be an important part in winning sprint races. Sprinting results are determined by several components of which the most important is the maximum running speed. The starting position is an important aspect of sprint, whereas, the optimal position and the horizontal velocity of the center of gravity (CG) can be considered as effective contributors for an efficient sprint performance (Mero, Luhtanen, & Komi, 1983). Other kinematics and dynamic variables such as force generation during the blocks, block time, block velocity and acceleration, block spacing and inclination can all be considered as important factors for sprint start performance (Mero, 1992; Menely & Rosemier, 1996). Moreover, Anthropometrical parameters such as thigh or calf girth, and skeletal muscle mass may affect sprint performance. It has been suggested that some anthropometrical parameters are necessary for good athletic performance in various sports (Kukolj , Ropret , Ugarkovic, & Jaric, 1999). For instance*,* Berg et al. (1986) stated that age, height and lean body weight were inversely related to sprint time but weight and percent body fat were positively related to sprint time. In other words, they reported a tendency for older and taller boys to run faster during a 30 m sprint. Information from such an analysis would be a useful instrument in talent identification for adolescent and young sprinters. Therefore, the purpose of this study was to identify the important of the block dynamics variables during the sprint start. Also of interest in this study was the influence of gender and selected anthropometric parameters on these variables.

METHODS: Sixty Flemish (30 boys and 30 girls) young elite sprint athletes (from 11 to 18 years old with a mean age of 14.7 ±1.8 years and 14.8±1.5 years for boys and girls respectively) volunteered. Informed written consent was obtained from all subjects prior to testing. Ethics approval was obtained for all testing procedures from the university ethics committee.Anthropometrical measurements were used to calculate corrected thigh girth (CTG) and corrected calf girth (CCG). Total body skeletal muscle mass (SMM) (Poortmans, Boisseau, Moraine, Reyes, & Goldman, 1950) was determined using under water weighting. Two start blocks (Berg - Olympia) were instrumented with piezo-electric load cell, allowing the measurement of the horizontal propulsion forces while in contact with the start blocks. The software allowed not only to obtain forces, but also related variables as velocity when leaving the blocks, average acceleration, impulse of rear and front leg.
For statistical analysis, the subjects were divided into 3 groups as tertiles according to their age, SMM, CTG and CCG (e.g. Table 1). All statistics were preceded by Kolmogorov-Smirnov normality test. As all subpopulations used proved to be normal, classical student T-

tests and ANOVA_s with Scheffé post hoc test were used for the detection of significant differences between subpopulations, mostly tertiles according to the different anthropometrical variables. All correlation factors presented in this study originate from classical linear regression analyses. The latter were all stepwise regressions because this is the most common method used by the researchers. All statistics were carried out using SPSS 16.0 and the significance level was set at p <.05.

RESULTS: Age and anthropometrical parameters in every groups or tertile are shown in Table 1.

Table 1: Anthropometrical values for the Tertile populations (Mean ±SD).

Parameters	1st Tertile (n= 20)	2nd Tertile (n = 20)	3rd Tertile (n = 20)
Age(years)	12.9 ±0.9	14.9 ±0.5	16.6 ±0.6
SMM (kg)	16.9 ±2.0	21.6 ±1.1	26.9 ±3.0
CTG (cm)	45.7 ±2.3	50.1 ±0.7	53.2 ±1.9
CCG (cm)	30.9 ±1.5	33.5 ±0.7	36.1 ±1.2

+

Dividing the sprinters into three tertiles according to age, the older sprinters in the third tertile showed a significantly higher block velocity (2.64±.031m/s) and acceleration (7.11±.099m/s²) than the first tertile (2.19±.043m/s and 5.78±1.36m/s² respectively). Similar results were found for tertiles according to SMM. In contrast, subjects divided according to thigh and calf girth, did not present significant difference between tertiles. The influence of age and selected anthropometrical variables as CTG, CCG, and SMM on reaction time of the rear and front legs was also investigated. The average reaction time for all sprinters did not show any significant difference in between the three tertiles for all anthropometrical parameters. As with reaction time, when comparing tertiles in between each other, no significant differences were found for block time. This means that age and the other anthropometrical variables did not influence the block time during the starting block phase. According to the force applying during the blocks, no significant differences were found between pre-tension forces of the rear and front legs. Age and anthropometrical parameters also didn't show any effect on pre-tension forces in between tertiles for all parameters. According to the results of the present study, the sprinters with higher values of SMM, CTG, and CCG due to their better sprint performance (measured by the 30 m sprint time), are expected to create larger maximal forces than younger sprinters. In this way, according to SMM, the average maximal forces at the front and rear legs of sprinters in the third tertile were respectively 557.2 ±68.9 N and 598.9 ±159.5 N, which are significantly higher values than for sprinters in the first tertile (317.2 ±68.9 N and 319.6 ±126.2 N for the front and rear leg respectively) (Figure 1).
As the same for the SMM variable, the older sprinters in the third tertile presented for the rear and front legs an average of respectively 517.4 ±176.9 N and 504.4 ±118.0 N for maximal force as with the younger sprinters showing respectively lower figures, 329.8 ±131.2 N and 324.4 ±89.4 N.

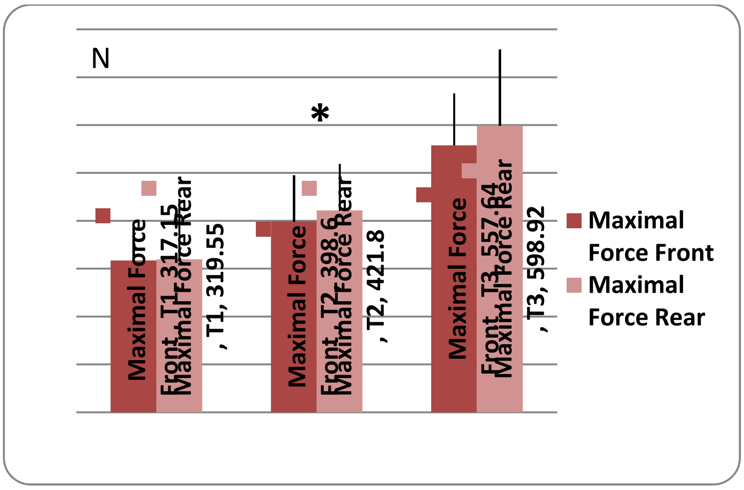

Figure 1: Maximal force for front and rear legs according to SMM tertiles (*P<0.05, T3/T2 and T1).

This was also true for impulses during the starting block phase. Moreover, according to the age, maximal forces generated with both rear and front legs presented a significantly increase in boys as compared to girls. For the impulse forces, on the other hands, only the front leg generated significantly higher impulses. The comparison between boys and girls revealed that the boys produce higher block velocity (2.62 ±0.55 m/s and 2.26 ±0.39m/s respectively), block acceleration (7.12 ±1.41 m/s² and 5.88 ±1.06 m/s² respectively), maximal force (518.5 and 496N for the rear and front leg and 376.2 and 354.2N for the rear and front leg respectively) and maximal impulse (47.5 and 110.3N.s for the rear and front leg and 40.8 and 83.2N.s for the rear and front leg respectively) than girls during the sprint start. In this study, the most significant starting block predictors for mean velocity were the maximum force exerted on the front and rear legs. As for the anthropometrical parameters of the sprinters, age, thigh girth, and skeletal body mass were the most important predictors of the velocity during the sprint run.

DISCUSSION: Although**,** the adolescent sprinters in this study showed lesser values for the block variables as compared to the adult elite sprinters from the scientific literature, however, as the same of adult sprinters, the high correlations between block velocity and maximal forces of the front and rear blocks were observed, making the latter strong starting block predictors for mean velocity.

Since the ability of a sprinter to leave the blocks at high velocity generally increases with increasing force, the production of force and power are essential for a good sprint running (Hafez, Roberts, & Seireg, 1985). As the same, these results also indicated that with increasing age and other important parameters such as skeletal body mass and thigh and calf muscle volumes, the ability of the adolescent sprinters for generating higher velocities and forces during block contact were increased. As with reaction time, when comparing tertiles in between each other, no significant differences were found for block time. This means that age and the other anthropometrical variables did not influence the block and reaction times during the starting block phase. The results above emphasize that not only block and reaction times had any influence on sprint running, but also age and the other anthropometrical variables.

Moreover, the greater impulse in the older sprinters can be explained due to the greater average force production by older adolescent sprinters than younger sprinters (Baumann, 1976). Hence, in the present study, because of lack of significant differences in block time between older and younger sprinters, the difference of the impulse can be interpreted by the larger amount of force production of the older sprinters due to a larger muscle mass and also body size.

Finally, as the maximum force on the front and rear legs has been shown by our study and literature (Mero & Komi, 1990) to be a best predictor for the starting action ,development of muscle forces should be considered an important factor for adolescent sprinters. Finally, as for the influence of the anthropometrical parameters of the sprinters the results indicate that age, thigh girth and skeletal muscle mass were the most important predictors of the velocity during a sprint run.

CONCLUSION: From the result it is clear that besides age and gender, anthropometrical variables significantly affect the starting block dynamics and sprint velocity of young sprinters during the start, and the maximum force on the front and rear legs has been shown to be a best predictor for the starting action.

REFERENCES:

Hafez, M.A., Roberts, E.M. & Seireg, A.A. (1985). Force and velocity during front foot contact in the sprint start. *Human Kinetics, Champaign, IL*. 350-355.

Menely, R.C & Rosemier, R.A. (1969). Effectiveness of four track starting positions on acceleration. *Research Quarterly,* 39, 161-165

Mero, A. & Komi, P.V. (1990). Reaction time and electromyographic activity during a sprint start, *European Journal of Applied Physiology* 61, 73-80

Mero A., Luhtanen P., & Komi, P.V. (1983). A biomechanical study of the sprit start, *Scandinavian Journal of Medicine and Sciences in Sports*. 5, 20-28

Poortmans, J., Boisseau, N., Moraine, J., Moreno-Reyes, R. & Goldman, S. (1950). Estimation of Total-Body Skeletal Muscle Mass in Children, *Medicine and Science in Sports and Exercise,* 37, 316-322

Kukolj, M., Ropret, R., Ugarkovic, D. & Jaric, S. (1999). Anthropometric, strength, and power predictors of sprinting performance*. Journal of Sports Medicine and Physical Fitness,* 39 (2), 120-122.

Berg, K., Miller, M., & Stephens, L. (1986). Determinants of 30 meter sprint time in pubescent males. *Journal of Sports Medicine and Physical Fitness* 26, 225-231.