DYNAMIC ANALYSIS OF THE STARTING ACTION AND STARTING ACCELERATION

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INTRODUCTION

The result in sprinting depends on numerous motor, bioenergetic, morphological and biomechanical parameters. The dynamics of sprinting speed consist of four phases: the start, start acceleration, maximum running speed and finish. The key factors of sprinting performance are the start and start acceleration, which according to the results of the researches carried out by some authors (Korchemny 1992, Delecluse, Coppenolle 1992, Vittori 1996) contribute 50% to 65% to the final result in the 100-m sprint. The purpose of the present research has been to establish the dynamic parameters of the start and the correlation between them and the parameters of start acceleration in top male and female sprinters.

METHODS

The sample of testees included 6 female and 8 male sprinters of the national athletic team of Slovenia. The parameters of the start were determined by means of special electronic starting blocks (MMIP) developed by the Laboratory for Biomechanics at the Faculty of Sport in Ljubljana in co-operation with the Department for the Processing of Materials at the Faculty of Natural Sciences and Technology in Ljubljana. The parameters of start acceleration were determined by means of photo cells (AMIS) placed at sections spaced at 5-10-15-20-25-30 m.

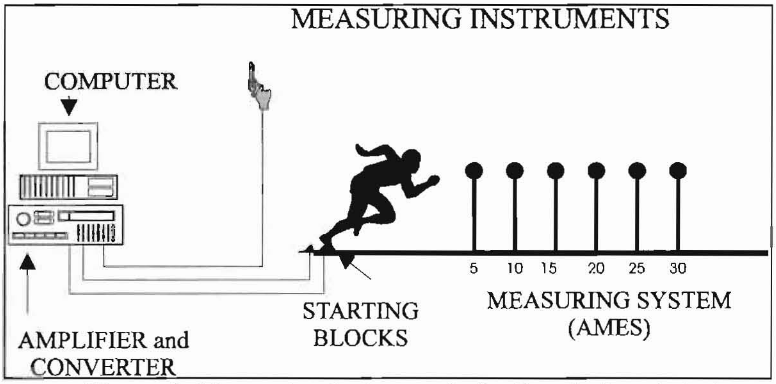

Figure 1: Measuring instruments for the start and start acceleration

Parameters of the start:

LRC - latent reaction time (time interval between the firing of the starter's gun and motor reaction)

MRC - motor reaction time (begin of motor reaction up to leaving the starting blocks)

SRC - start reaction time (time interval between the firing of the starter's gun and leaving the starting blocks)

MSP - maximum pressure (top of the curve of force development on the front and rear starting block, respectively.)
TMP - point of maximum pressure (the time which the sprinter requires to develop maximum force on the starting block).
ISP - impulse of the push-off force (force development in unit of time)
MGS - maximum force gradient (steepness of the force growth in unit of time)
PBL - distance between the starting block and start line

Parameters of the start acceleration:
5M-10M-15M-20M-25M-30M - points of measured times of start acceleration

RESULTS

On the basis of dynamic parameters of the start (Fig. 2 and 3) and the data given in Tables 1 and 2, the following can be established:

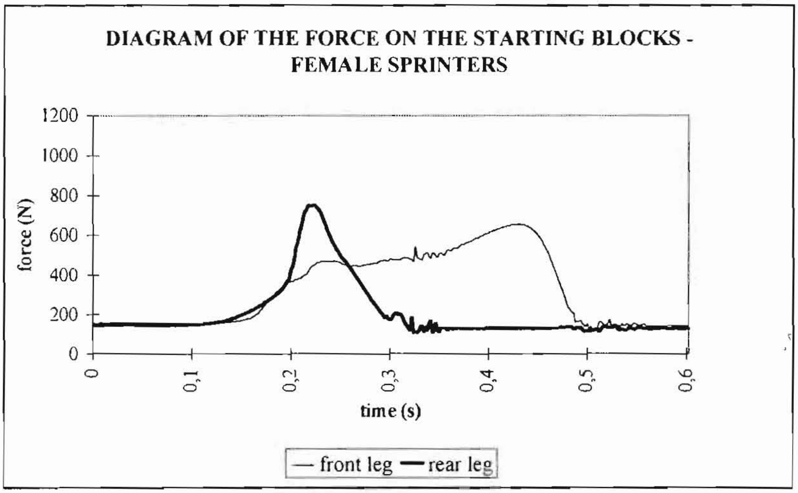

Figure 2: Diagram of the force acting on the starting blocks - female sprinters

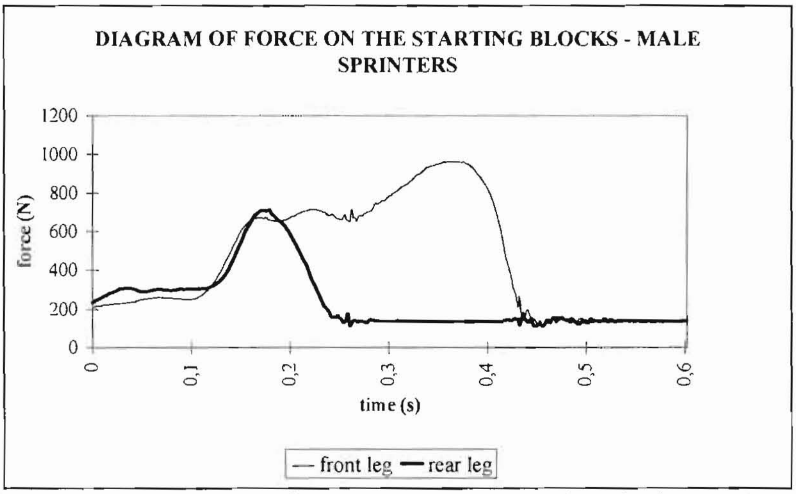

Figure 3: Diagram of the force acting on the starting blocks - male sprinters

Dynamic parameters of the start indicate that between male sprinters and female sprinters there are no significant differences as regards the latent reaction time. Male sprinters leave the front starting block on average by 0.02 sec faster than female sprinters and develop in the first 5 meters after the start an average speed that is by 0.24 m/sec higher.

Table 1: Parameters of the start and start acceleration- female sprinters (N=6) and male sprinters (N=8)

		male						female					
			r						r				
V	E	X	5 m	10 m	15 m	20 m	30 m	X	5 m	10 m	15 m	20 m	30 m
LRCR	s	0,12	0,30	0,02	0,19	0,16	0,18	0,12	0,54	0,62	0,63	0,62	0,55
LRCF	s	0,13	0,17	0,14	0,17	0,14	0,14	0,13	0,33	0,41	0,41	0,40	0,34
MRCR	s	0,17	0,49	0,44	0,52	0,33	0,37	0,19	0,33	0,36	0,37	0,37	0,29
MRCF	s	0,35	0,34	0,41	0,70*	0,63	0,67*	0,37	0,30	0,32	0,29	0,27	0,31
SRCR	s	0,29	0,68*	0,69*	0,39	0,22	0,24	0,32	0,77*	0,92**	0,90**	0,87**	0,86**
SRCF	s	0,48	0,53	0,83**	0,65*	0,59	0,64*	0,50	0,73*	0,83*	0,80*	0,77*	0,75*
TMPR	s	0,21	0,70*	0,55	0,47	0,31	0,35	0,21	0,33	0,37	0,38	0,41	0,32
TMPF	s	0,41	0,65*	0,59	0,57	0,50	0,55	0,43	0,55	0,52	0,52	0,51	0,45
MSPR	N	731	0,12	0,25	0,34	0,37	0,43	525	0,52	0,66	0,66	0,65	0,72
MSPF	N	779	0,28	0,65*	0,78**	0,74*	0,74*	587	0,18	0,26	0,29	0,38	0,35
ISPR	Ns	59	-0,22	-0,21	-0,32	-0,41	-0,45	52	-0,68	-0,71*	-0,74*	-0,73*	-0,69
ISPF	Ns	168	-0,23	-0,41	-0,54	-0,48	-0,48	117	0,22	0,11	0,12	0,08	0,01
MGSR	N/s	1732	-0,19	-0,15	-0,19	-0,18	-0,25	1506	-0,20	-0,36	-0,35	-0,36	-0,45
MGSF	N/s	993	-0,28	-0,44	-0,60	-0,53	-0,55	985	-0,50	-0,35	-0,43	-0,52	-0,48
PBLF	cm	53	0,00	0,05	0,02	0,11	0,00	49	0,56	0,30	0,36	0,37	0,27
PBLR	cm	82	0,05	0,23	0,26	0,42	0,32	71	0,24	0,01	0,01	0,02	0,02

Legend: V - variable; E - unit of measurement; X - arithmetic mean; r - correlation; R- rear starting block; F - front starting block, * p<0.05, ** p<0.01.

The most apparent differences can be seen in the maximum pressure exerted on the starting blocks. The average force developed on the front starting block by male sprinters is 779 N, while that developed by female sprinters amounts to 587 N. Top sprinters develop a force of 1000 N and more (Delecluse, 1992). Male sprinters develop a more uniform force on the starting blocks. The difference between the front and the rear block is only 48 N. In female sprinters, this difference amounts to 62 N. The average force impulse on the first starting block amounts to 168 Ns in male sprinters, while in female sprinters the average impulse is only 117 Ns. This discrepancy is the result of the difference in the ability to activate strength in a unit of time. Correlation analysis shows clearly that in female sprinters, latent reaction time is an important factor of the start and start acceleration, whereas in male sprinters, motor reaction time is important. In the first 10 metres, the correlation between the start reaction time and start acceleration is very high, which fact applies especially to female sprinters. In female sprinters, the start reaction time of the rear leg is more important, while in male sprinters it is that of the front leg. In female sprinters, start acceleration is associated with the maximum pressure exerted on the rear starting block, while in male sprinters the pressure on the front starting block is decisive. The parameters of the start show that female sprinters perform the push-off from the starting blocks in a concentric manner, while male sprinters perform it in an eccentric-concentric manner, while male sprinters perform it in an eccentric-concentric manner. The latter is better from the aspect of efficiency owing to the fact that utilisation of elastic energy of muscles is involved. The male sprinter who achieved a maximum start speed of 3.87 m/sec in the first five metres also developed the largest force on the front starting block, namely 1038 N. Sprinters whose performance is better differ from the poorer ones not only in the magnitude of the developed force, but also in the time TMP required to develop it. The time required for the development of the maximum force on the front and rear starting block has a high correlation, especially with the start acceleration in the first 5 metres. Within the group of male and female sprinters there exist large differences in the gradient of the force exerted on the starting blocks. Better male and female sprinters have a larger force gradient on the front starting block. This parameter is significantly correlated with start acceleration in female athletes in the first 5 metres, while in male athletes the correlation with start acceleration takes place between 10 and 30 metres. The position of starting blocks (the distance of the first starting block from the start line and the distance between the starting blocks) has no direct effect on the development of the start speed. We can only establish that the starting blocks placed at a larger distance enable a shorter reaction time in male sprinters and a larger maximum force on the rear starting block in female sprinters. Although the studies conducted so far (Korchemny, 1992; Vittori, 1996) indicate that a larger distance between the starting blocks and the start line should enable a more efficient push-off and a more rational angle of the take-off from the starting blocks (42-56 degrees) and thereby a better transition into start acceleration, we could not establish this fact in our male and female athletes.

CONCLUSION

Measuring instruments enable us to determine some of the key parameters of the sprinting speed, especially those which are associated with the start and start acceleration. On the basis of the data obtained in this way, it is possible to optimise the start with respect to the athlete's motor abilities and characteristics. Indirectly, the results can also help us in improving the planning and control of the training of sprinters.

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