The Effects of Shortening the Distance between Hurdles during Training

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INTRODUCTION

The high hurdle events consists of succesive changes in cycling (sprinting) and non-cycling (hurdle clearing) movements.

This characteristic is the basic element of the events correct technique.

It is acceptable that in jumping events, the high performance athletes follow a distinct preparatory phase just before the actual jump in order to achieve a position that facilitates a better transition from running to jumping conditions (Nixdorf. 1983, Tsarouchas. 1986).

The purpose of the present study was to investigate shorter distances between the hurdles during training, as a means to improve the preparation phase of hurdle clearance.

METHODOLOGY

For the investigation of the kinematic characteristics of the preparation phase in thw 100 m hight hurdler, the last two strides between the 2nd and 3rd hurdle were filmed (LOCAM 16 mm camera - 100 frames/sec). The subjects were 3 girl hurdlers from the Greek National Team.

The dynamic characteristics of the 2 strides were evaluated by means of a force platform (Kistler) which was firmly placed and leveled with the floor.

The athletes ran four times 50 meters over four hurdles, two trials for each measured support, using two different distances between the hurdles: a) The international standard distance of 8.50 m between hurdles, and b) 8.00 m between hurdles.

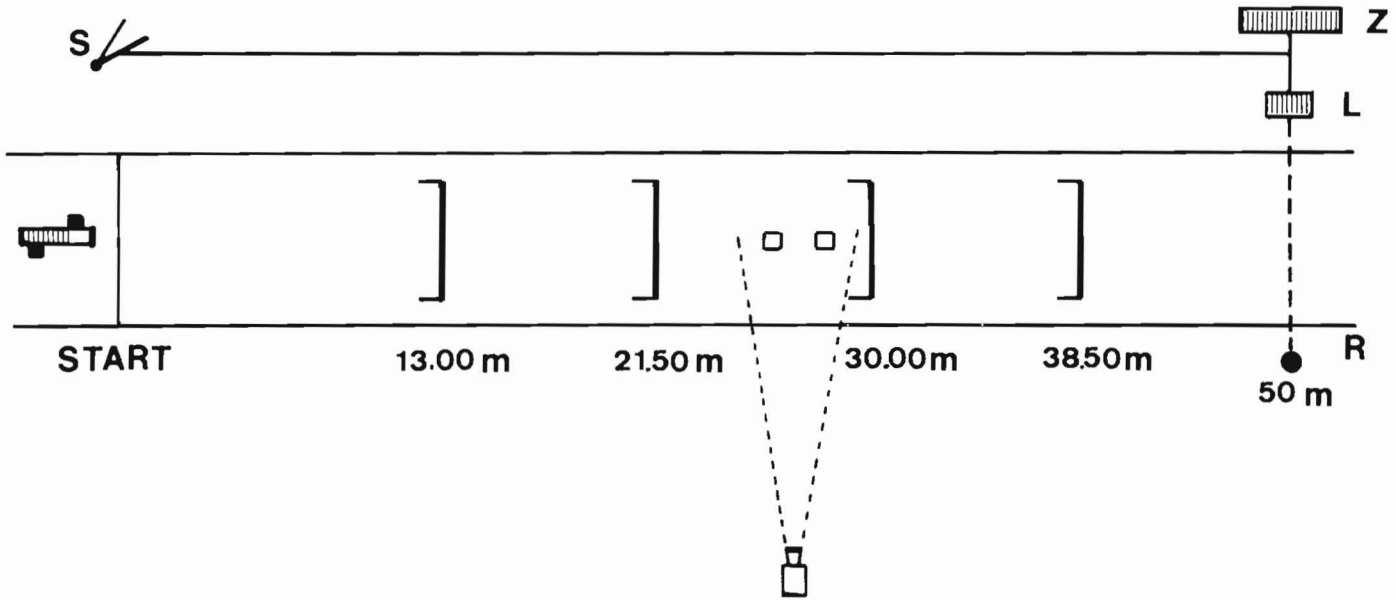

Fig. 1. Set up for the measurement.

In order to obtain the scores of the dynamic movements made by the athletes, they had to step on the force platform (0.40 m wide - 0.60 m long) with the whole sole of the foot. Since the force platform could not be moved, the starting line, the hurdles and the finish line were moved. The appropriate distances between hurdles and force platform were estimated by analysing actual high speed films of the same athletes.

RESULTS

Dynamic analysis for the 8.50 m.

The run between the hurdles should be determined by maximization of the horizontal velocity and optimization of the hurdle clearance. The difference between races with and without hurdles lays in the fact that races without hurdles have almost steady speed values in certain parts of the race. However races with hurdles show great discrepancies of the CG (Center of Gravity) velocity (Table 1).

Table 1. Differentiation of the horizontal velocity during the last 2 supports, before the clearance of the 3rd hurdle.

Name	2nd hurdle	3rd hurdle
P.S. (13.80 sec)	0.22	−0.49
P.F. (14.72 sec)	0.35	−0.57
N.K. (15.08 sec)	0.26	−0.66

We can observe that all athletes decrease their speed considerably during the support for the clearance of the 3rd hurdle.

The changes in every element of the CG velocity during the support phase are proportionally equal with the corresponding ground reaction.

The duration of the applied strength in two directions can be seen in figure 2.

The forces which react in an horizontal direction (Fx) are of great importance for the time in the 100 m hurdle race.

If $Fx<0$, we observe a reduction in the horizontal velocity of CG.

If $Fx>0$, we observe an increase in the horizontal velocity of CG.

During the last-before the clearance-support, the horizontal retardation force lasts for a longer period of time (Table 2), the acceleration forces reduce and, as a result, the horizontal velocity decreases.

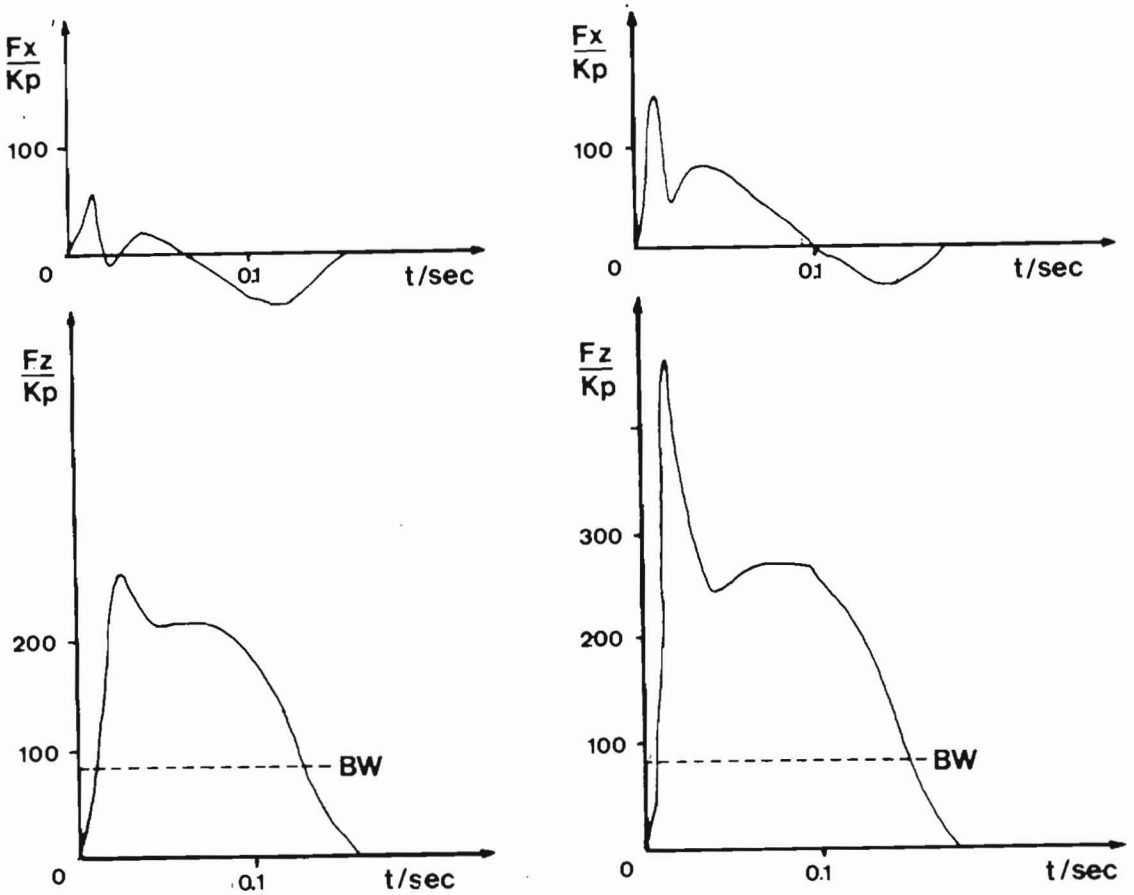

Fig. 2. Duration of reaction strengths Fx, Fz in the last 2 supports before the clearance of the 3rd hurdle (P.S. 13.80 sec).

Table 2. Time analysis of the last 2-before the clearance of the 3rd hurdle-supports.

Name	One before last support			Last support		
	Tts	Rt	At	Tts	Rt	At
P.S.	0.135	0.054	0.081	0.142	0.080	0.062
P.F.	0.136	0.050	0.086	0.152	0.086	0.066
N.K.	0.139	0.052	0.087	0.147	0.086	0.061

Tts = Total time of support. (sec)
Rt = Retardation time of the CG. (sec)
At = Acceleration time of the CG. (sec)

Fz can give us clues for the forces which, during the support phase, accelerate or decelerate the CG in the vertical axis. The sudden increase of this force, during the last support (right after the beginning of the support before the clearance), indicated the absurd placement of the heel on the ground. Maximum values not exceeding 7 times the athlete's body weight can be observed at this moment.

The forces that develop on the vertical axis of the movement overload the participating joints.

The horizontal and vertical reaction forces observed during the last 2 strides before the hurdle clearance, provide, from biomechanical point of view useful conclusions about the quality of the performed technique.
P.S. (13.80 sec)
N.K. (15.08 sec)

Dynamic analysis for the 8.00 m

The use of smaller distances between the hurdles is a specific training method used by many coaches.

The purspose of this study is to evaluate the above mentioned method in regard to:

1) Increase of stride frequence.
2) Better running technique.
3) Improvement of horizontal velocity.

Observing the changes in the horizontal velocity of the CG, an improvement, during the last 2 supports before the hurdle clearance were 0.08 to 0.12 m/sec (Table 3-compared with table 1).

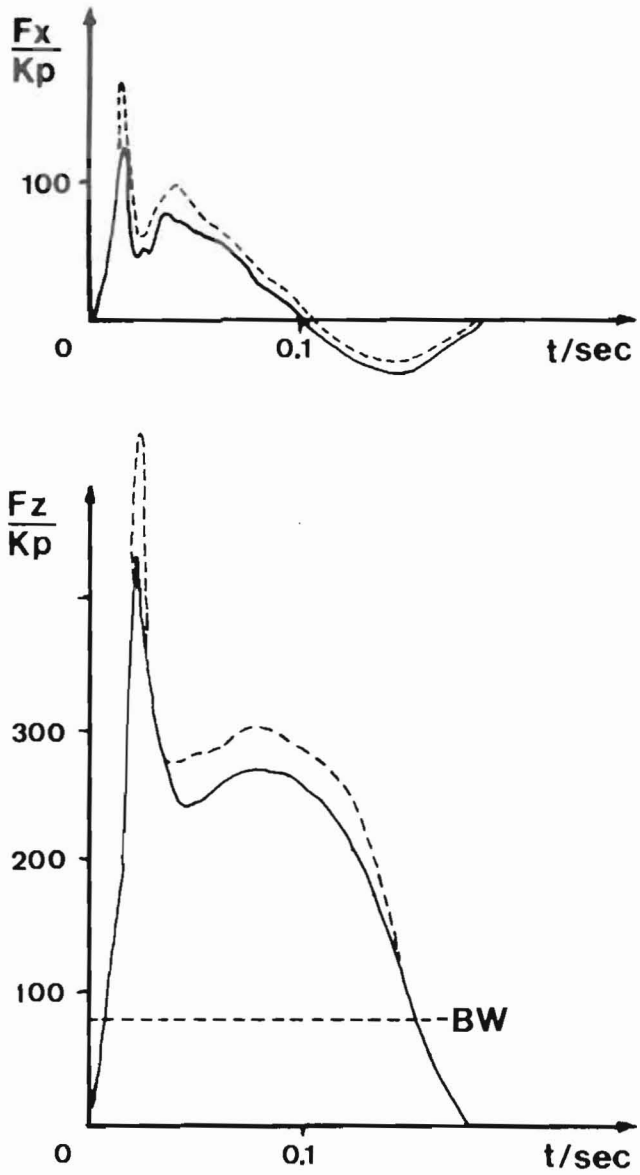

Fig. 3. Horizontal and Vertical reaction forces developed during the support prior to the hurdle clearance.

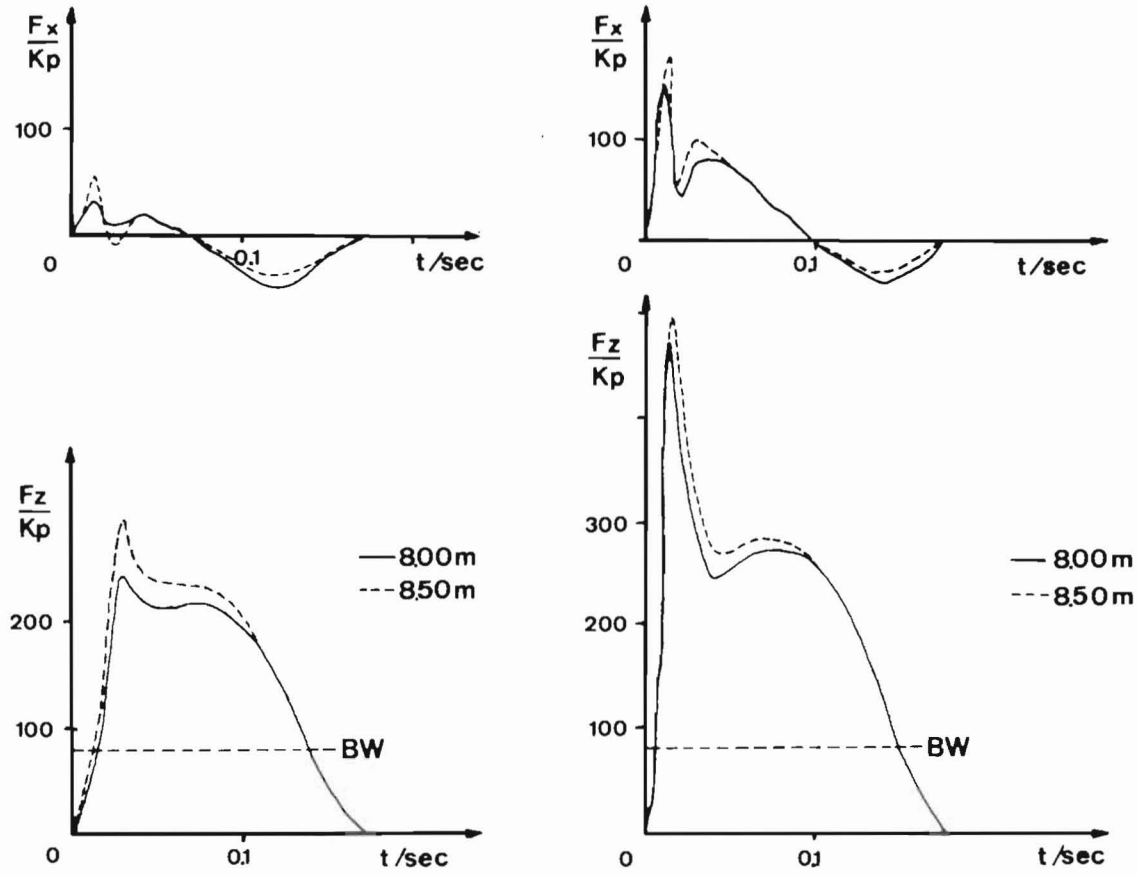

Fig. 4. Comparison of the ground reaction forces (Fx, Fz) during the last 2 supports before the clearance of the 3rd hurdle (P.S. 13.80 sec).

Table 3. Differentiation of the horizontal velocity during the last 2 supports before the clearance of the 3rd hurdle.

Name	2nd hurdle	3rd hurdle
P.S.	0.27	−0.42(+0.12 m/sec)
P.F.	0.38	−0.52(+0.08 m/sec)
N.K.	0.29	−0.57(+0.12 m/sec)

The time analysis of the last 2 strides is shown in Table 4.

Kinematic analysis

The evaluation of all athletes CG over the hurdle decreases from 0.03-0.06 m when the distance between the hurdles is decreased from 8.50 m to 8.00 m.

It is important to mention that the deceleration time decreases by 0.02-0.06 sec (see table 2 and 4). The total acceleration increases from 0.12-0.14 when the support duration is steady. In order to investigate the improvement of the running technique the changes in lower limb angles during the supports were analysed.

Table 4. Time analysis of the last 2 strides before the clearance of the 3rd hurdle.

Name	One before last support			Last support		
	Tts	Rt	At	Tts	Rt	At
P.S.	0.135	0.052	0.083	0.142	0.080	0.062
P.F.	0.136	0.044	0.092	0.148	0.082	0.066
N.K.	0.138	0.048	0.090	0.134	0.076	0.058

Tts = Total time of support (sec)
Rt = Retardation time of the GG (sec)
At = Accceleration time of the CG (sec)

The most noticeable differences are the following:

1) The angle between the thigh of the swing leg and the horizontal, during the swing before the clearance suport, decreases by 12°.

2) The angle of the Knee (Support leg) during the last stride decreases by 5°. On the contrary, when the distance between the hurdles is 8.50 m, the same angle increases by 7°. This is a reason for the CG lowering during this support.

3) Some relatively minor vertical displacements can be observed at the action points (heel, Knee) of the swing leg (during support). It is important to notice that during the preparation phase (last support on the 8.00 mark) the action point of the heel moves lower than the action point of the knee.

In this way the athletes aim to cover the horizontal distance of the next stride in the straightest possible manner, that is, in the fastest possible time. Also, in order to reduce the time of the last stride (8.00 m), the action point of the knee slows down earlier, thus resulting in increasing of the angle between the thigh and the horizontal level.

It is obvious that there is a preparation phase, similar to the one that jumpers employ before the take-off, which shows down the horizontal velocity during the take-off for hurdle clearance.

CONCLUSION

– During the last two strides, before the clearance of the 3rd hurdle, an increase up to 0.12 m/sec can be observed (P.S. 13.80 sec). This score differs from athlete to athlete and indicates a difference in technique during the last 2 strides before the clearance of the 3rd hurdle.

— The comparison between the horizontal and vertical reaction forces during the last two strides before the take off, provides useful information for the running technique.

It is important, for better results, for the coach to pay attention not only to the characteristics of speed, but also to the improvement of the running technique.

A cooperation between coach and biomechanist may produce better performances by the athlete.

REFERENCES

Mero, A. und P. Luhtanen. Biomechanische Untersuchung des Hurdenlaufs wahrend der Weltmeisterschaften in Helsinki. Leistungssport 1, s. 42-43, 1986.

Nixdorf, E. and P. Brueggemann. Zur Absprungvorbereitung beim Weitsprung - Eine biomechanische Untersuchung zum Problem der Koerperschwerpunktsenkung. Die Lehre der Leichtathletik 1539-1541, 1983.

Tsarouchas, L., C. Papadopoulos and A. Giavvoglou. Preparation phase for the clearance of the hurdle in the 110 m high hurdles run, 1987.

Ward, T. and D. India. Temperal and Kinematik facts on 100 m hurdling high level performers. Track and Field quart, Rev. Kalamazoo, S. 30-32, 1982.

Williams, D. Improving high hurdles clearance. Brit. J. Phys. Educ., London 6, S. 17-18, 1975.