VARIATION OF PARAMETERS DESCRIBING GROUND REACTION FORCES DURING CHILDREN'S RUNNING

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INTRODUCTION

The purpose of the present study was to investigate the variations in critical parameters describing ground reaction forces evoked in running at various speeds of the subjects non specialized in a running competition.

METHODOLOGY

For this aim the support phase was evaluated, separately for the left and right foot (but for the moment only the results for the right foot are presented) of eight (8) non-runners (boys - 14 years old) who were running repeatedly at three speeds 7.58 m/s (as a sprint running), 6.11 m/s (as a middle distance running) and 5.02 m/s (as a long distance running). The three speeds are proportionate to the mean velocities of the best performances in their running competition of the six (6) best Greek sprinters, middle-distance and long-distance runners respectively.

The three (3) components of GRF evoked in running, have been measured using a KISTLER force platform inserted at the ground level and a photocell timing system was used to monitor the running speed while a video-recorder system was used to control the "normal" footstrike and in order to have additional information about temporal parameters.

A computer program was developed for analysing the curves data and a number of 89 obtained from this analysis parameters, were submitted oneself to descriptive statistics (mean value, SD) and hypothesis paired T-Tests (significance) analysis.

RESULTS

The absolute temporal parameters are verified significantly at three speeds of running as they are presented in Table 4 and in Figures 2,4 with a clear tendency for decrease of mean magnitudes associated with the increase of speed.

The relative temporal parameters presented in Table 1 and Figures 3,5 are not verified significantly except TR6 and TR7 parameters.

The three axis forces do not present significant differences except the maximal vertical force (ZA3) and the braking (Y4) and propelling (Y8) forces. (Fig. 6)

The most significant differences were found in the impulse parameters, mainly between the sprint and middle distance running and between sprint and long distance running. (Fig.7,8)

CONCLUSIONS

The non-difference in relative temporal parameters indicate a similar pattern in the distribution of the characteristics of force components at three speeds of running as the most significant differences between impulses parameters are not a result of increase of force parameters but a result only of the decrease of the absolute time parameters associated with an increase in running velocity.

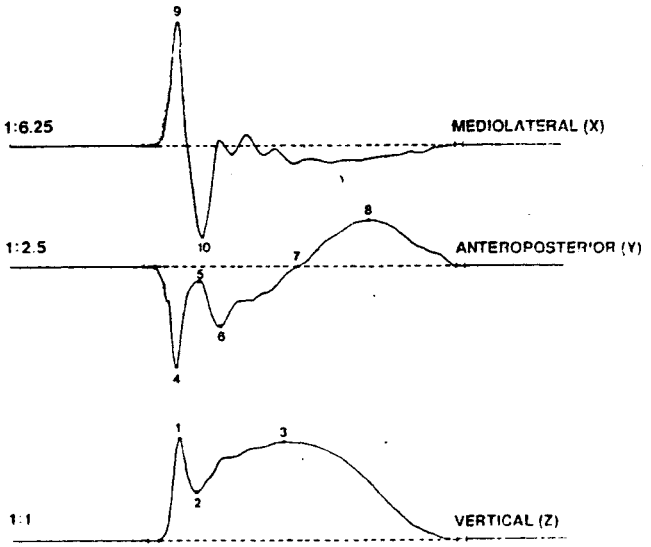

Figure 1: Typical curves of ground reaction forces and their critical moments for evaluation

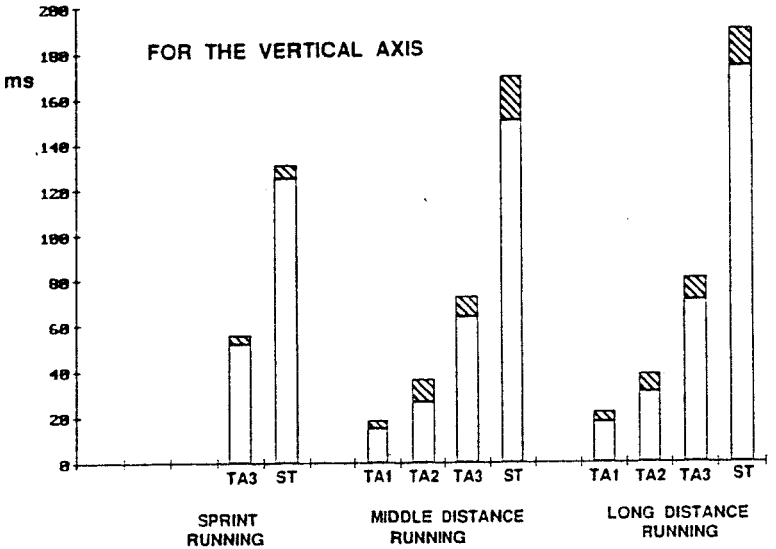

Figure 2: Absolute temporal parameters for the vertical axis

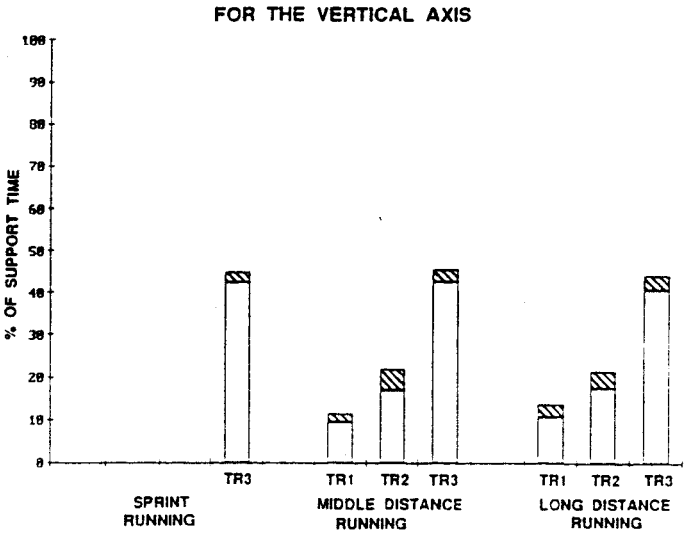

Figure 3: Relative temporal parameters for the vertical axis

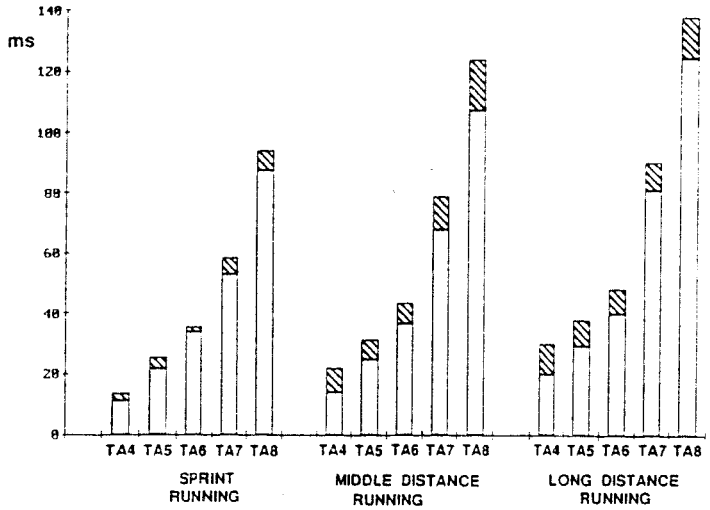

Figure 4: Absolute temporal parameters for the anteroposterior axis

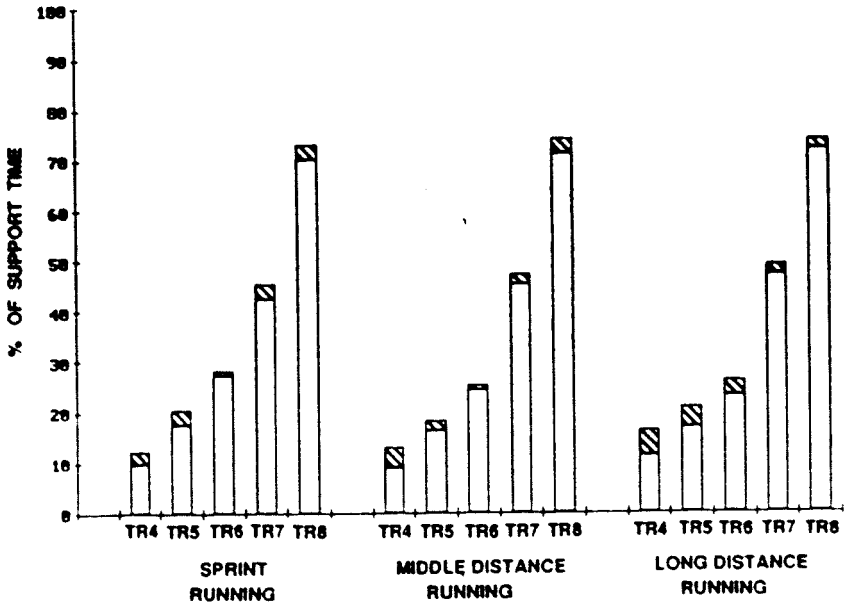

Figure 5: Relative temporal parameters for the anteroposterior axis

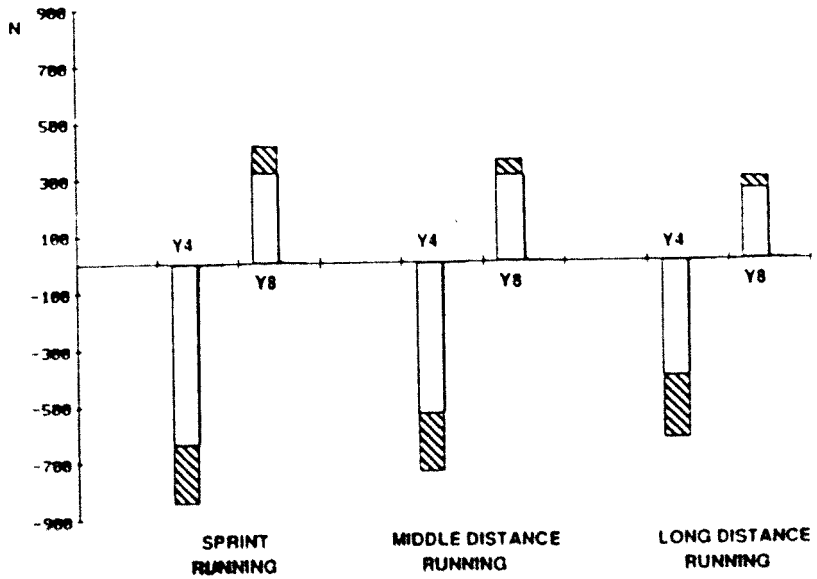

Figure 6: Braking and propelling forces

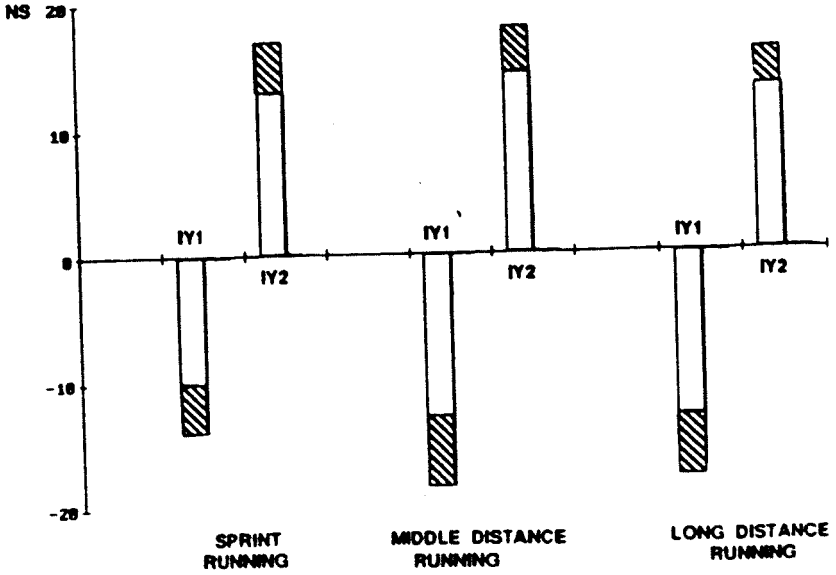

Figure 7: Impulses for the anteroposterior axis

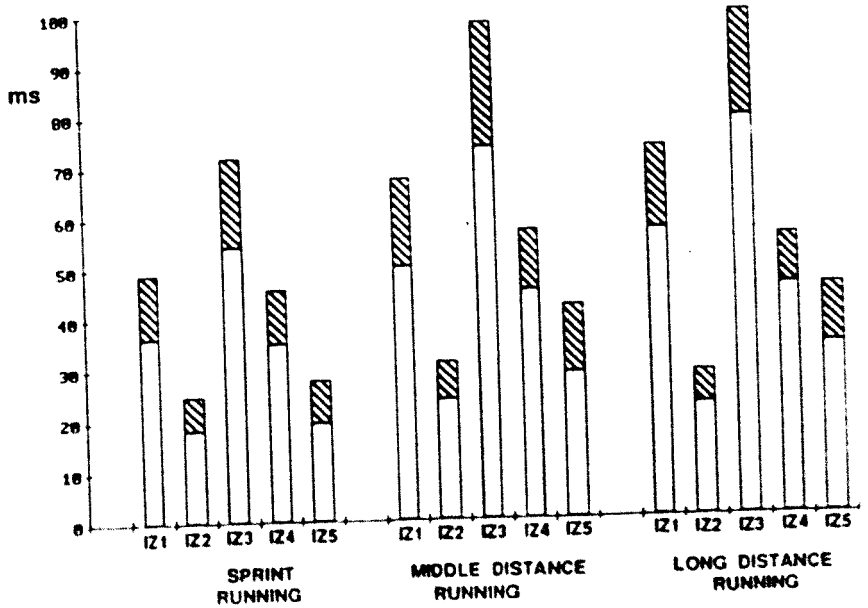

Figure 8: Impulses for the vertical axis

TABLE 1
Variation and significance of relative temporal parameters

	SPRINT		MIDDLE DISTANCE RUNNING		LONG DISTANCE RUNNING		SPRINT RUNNING
TR1			0,09 ±0,02	NS	0,11 ±0,03		TR1
TR2			0,17 ±0,05	NS	0,17 ±0,04		TR2
TR3	0,42 ±0,03	NS	0,42 ±0,03	NS	0,41 ±0,03	NS	TR3
TR4	0,10 ±0,03	NS	0,09 ±0,04	*	0,11 ±0,05	NS	TR4
TR5	0,17 ±0,03	NS	0,16 ±0,02	NS	0,17 ±0,04	NS	TR5
TR6	0,27 ±0,01	**	0,24 ±0,01	*	0,23 ±0,03	**	TR6
TR7	0,42 ±0,03	*	0,45 ±0,02	ID	947 ±0,02	**	TR7
TR8	0,70 ±0,03	*	0,71 ±0,03	NS	0,72 ±0,02	ID	TR8
TRX1	0,48 ±0,08	NS	0,44 ±0,05	NS	0,75 ±0,00	ID	TRX1

P < 0,001 ***
P < 0,01 **
P < 0,05 *
P < 0,1 ID
P > 0,1 NS

TABLE 2
Variation and significance of forces

	SPRINT		MIDDLE DISTANCE RUNNING		LONG DISTANCE RUNNING		SPRINT RUNNING
ZA1			1662,50 ±433,57	NS	1439 ±301,30		ZA1
ZA2			1045,33 ±375,81	NS	978,63 ±360,83		ZA2
ZA3	1393,12 ±376,34	**	1514,75 ±395,01	NS	1484,25 ±340, 49	*	ZA3
ZR1			3,52 ±0,84	NS	3,24 ±0,45		ZR1
ZR2			2,16 ±0,48	NS	2,14 ±0,44		ZR2
ZR3	3,21 ±0,32	NS	3,34 ±0,12	NS	3,31 ±0,25	NS	ZR3
Y4	-637,37 ±209,54	*	-532,37 ±210,65	**	-405,63 ±221,09	**	Y4
Y8	318,62 ±97,90	NS	307,87 ±60,10	***	250,63 ±44,89	**	Y8

P < 0,001 ***
P < 0,01 **
P < 0,05 *
P < 0,1 ID
P > 0,1 NS

TABLE 3
Variation and significance of force impulses

	SPRINT		MIDDLE DISTANCE RUNNING		LONG DISTANCE RUNNING		SPRINT RUNNING
IZ1	36,17 ±12,71	***	49,81 ±17,50	*	56,50 ±16,38	***	IZ1
IZ2	17,87 ±6,82	**	23,36 ±7,41	NS	22,01 ±6,42	**	IZ2
IZ3	54,05 ±17,62	***	73,17 ±24,60	ID	78,51 ±20,86	***	IZ3
IZ4	34,90 ±10,66	***	44,75 ±12,11	NS	45,14 ±9,99	***	IZ4
IZ5	19,15 ±8,36	**	28,42 ±13,32	ID	33,37 ±11,61	***	IZ5
IY1	-10,10 ±3,99	*	-12,92 ±5,63	NS	-13,06 ±4,86	**	IY1
IY2	12,90 ±4,13	**	14,29 ±3,69	**	12,96 ±3,01	NS	IY2

P < 0.001 ***
P < 0.01 **
P < 0.05 *
P < 0.1 ID
P > 0.1 NS

TABLE 4
Variation and significance of absolute temporal parameters

	SPRINT		MIDDLE DISTANCE RUNNING		LONG DISTANCE RUNNING		SPRINT RUNNING
TA1			[illegible] ±1,68	NS	[illegible] ±4,53	NS	TA1
TA2			[illegible] ±10,31	NS	[illegible] ±7,98	NS	TA2
TA3	[illegible] ±3,76	*	[illegible]	**	[illegible] ±9,99	**	TA3
TA4	[illegible] ±2,41	NS	[illegible] ±7,30	**	[illegible] ±10,14	*	TA4
TA5	[illegible] ±3,81	NS	[illegible] ±9,76	*	[illegible] ±8,37	*	TA5
TA6	33,75 ±1,75	NS	36,30 ±7,33	*	40,00 ±8,57	*	TA6
TA7	53 ±5,83	**	[illegible]	***	81,25 ±9,44	***	TA7
TA8	87,37 ±6,43	**	107,37 ±16,68	***	124,62 ±13,76	***	TA8
ST	124,75 ±5,97	**	150,37 ±19,43	***	173,62 ±16,49	***	ST
TAX1	60,25 ±48,72	*	97,37 ±58,34	ID	131,87 ±54,29	**	TAX1

P < 0.001 ***
P < 0.01 **
P < 0.05 *
P < 0.1 ID
P > 0.1 NS

TABLE 5
Identification of temporal and dynamic parameters

VERTICAL (z)	ANTEROPOSTERIOR (y)	MEDIOLATERAL (x)	TEMPORAL (T)
ZA1 - 1st absolute max. force	Y4 - 1st max braking peak	IX1 - total impulse on the right (-) of the running direction	TA1 - abs. time to ZA1
ZR1 - 1st relative max force	Y5 - min braking peak	IX2 - total impulse on the left (+) of the running direction	TR1 - rel. time to ZA1
ZA2 - absolute min force	Y6 - 2nd max braking peak	IX - algebraic impulse (IX1 + IX2)	TA2 - abs. time to ZA2
ZR2 - relative min force	Y8 - max propelling peak		TR2 - rel. time to ZA2
ZA3 - 2nd absolute max force	IY1- braking impulse		TA3 - abs. time to ZA3
ZR3 - 2nd relative max force	IY2- propelling impulse		TR3 - rel. time to ZA3
IZ1*- impulse on Z axis for braking duration	IY - algebraic impulse (IY1 + IY2)		TA4 - abs. time to Y4
IZ2*- impulse on Z axis for propelling duration			TR4 - rel. time to Y4
IZ3*- total impulse on Z axis			TA5 - abs. time to Y5
IZ4*- impulse on Z axis to 2nd max force			TR5 - rel. time to Y5
IZ5*- impulse on Z axis from 2nd max force to end of the support			TA6 - abs. time to Y6
			TR6 - rel. time to Y6
			TA7 - abs. time of braking phase
			TR7 - rel. time of braking phase
			TA8 - abs. time to Y8
			TR8 - rel. time to Y8
			ST - support time
			TAX1- abs. time of IX1
			TRX1- rel. time of IX1
			TAX2- abs. time of IX2
			TRX2- rel. time of IX2

* for the vertical force minus BW