EFFECTS OF A SUPRAMAXIMAL RUN TO EXHAUSTION ON RUNNING ECONOMY AND RUNNING KINEMATICS.

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INTRODUCTION.

Running economy defined as the amount of energy (VO2) spent for a submaximal velocity reflects the sum of both aerobic and biomechanical demand and can be seen as an indicator of the runner's efficiency. Numerous studies have tried to alter running economy, after experimental protocols but results are inconsistent (Morgan et al., 1989; Bailey and Pate, 1991). Among them, little is known on the effect of fatigue on the oxygen consumption. Previous research focused on the effect of long run in endurance runners and results from these studies suggest that a 30min. run (89% VO2max) would not raise the aerobic demand (Morgan et al., 1990; Williams et al.,1988). However it is possible that, in well trained long distance runners, these protocols very close to tlie training pace would not alter running economy as well as the running gait. On the contrary, an intense run leading to exhaustion might produce changes in running gait and affects running economy. The purpose of this study was, therefore to quantify total intra-individual variability in running economy, Stride kinematics after a supramaximal run to exhaustion in 400m runners.

METHODOLOGY

Ten runners took part in this study. All subjects had been following a training program for a minimum of 4 years and were experienced treadmill runners. They were selected after a maximal protocol to be liomogeneous on $\dot{V}O2$ max ($63{,}5 \pm 2{,}1$ $ml.kg^{-1}.min^{-1}$) and on the speed reached with V 0 2 max (Vmax: 19 $km.h^{-1}$). After completing a 15 min accommodation run, each subject performed a submaximal run (T1), 6 min in length and 0% grade at 75% Vmax (14,5$km.h^{-1}$). Following this run subjects completed a supramaximal run to exhaustion at 22 $km.h^{-1}$ and 7% grade according to the protocol described by Schnabel and Kindermann (1983). Half an hour (T2) and one hour after this run (T3), each subject repeated the 6 min submaximal run (figure 1). During supramaximal runs physiological parameters were continuously recorded. During each submaximal runs, physiological parameters were recorded during the last 3 min and subjects were filmed between the second and the third minute. Stride rate was continuously recorded by an impact monitor fixed on the runner's right shoe.

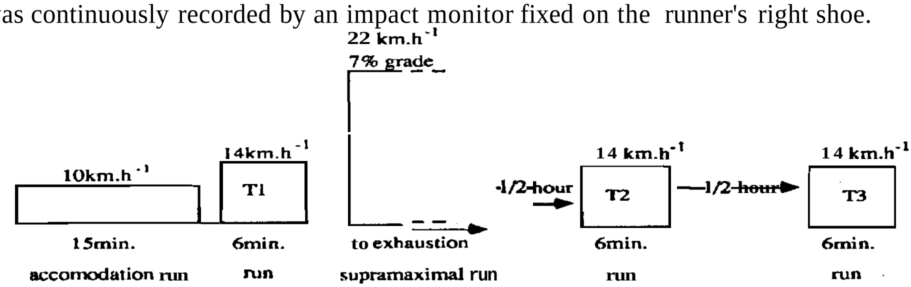

Figure 1. Experimental Protocol.

RESULTS

Results of the physiological sollicitation during the supramaximal run were in accordance with those found by Schnabel and Kindermann (1983) with the same population.

Mean time to exhaustion was 98.2 ± 16 sec and mean post exercise blood lactate peak was 16,71 ± 2,31mmol.l^{-1}.

Submaximal data for running economy (RE), heart rate (HR), ventilation (VE), lactate concentration (LA), stride rate (SR), CG oscillation (Osc CG), plantar flexion at toe off (PlantFlex), maximal Thigh flexion (TH Flex), and maximal Knee flexion during support time (Kn Hex) are shown table 1.

No statistical increase were found in running economy , heart rate, ventilation or respiratory frequency. As well, no difference was found in stride rate (mean and variability on 30 strides) and most of the running kinematics. However, we found a significant decrease in plantar flexion at toe-off ($P<.005$) and a significant increase in lactate concentration ($P<.005$), 1/2 hour after the test.

Table 1. Physiological parameters and kinematics recorded during the submaximal tests.

Parameters	T1	T2	T3
RE (ml.kg^{-1}.min^{-1})	39,8 ± 3,5	39,6 ± 4,2	39,4 ± 4,2
HR (bt.min^{-1})	140,6 ± 15,2	143,7 ± 7,7	142,8 ± 10,3
VE (l.min^{-1})	80,6 ± 12,3	80,2 ± 15,3	79,8 ± 12,4
LA (mmol.l^{-1})	3,6 ± 0,2	6,8 ± 0,6*	4,1 ± 0,4
SR (msec)	740 + 52	738 ± 65	743± 58
Osc CG (cm)	12,7 ± 1,8	12,5 ± 2,8	12,6 ± 2,8
Plant Flex (deg)	70,9 ± 5,8	65,7 ± 2,7*	67,3 ± 3,4*
Th Flex. (deg)	20,4 ± 1,6	19,04 ± 1,06	19,4 + 1,8
Kn Flex (deg)	46,1 ± 4,6	44,9 ± 4,2	44,8 ± 4,8

Differences with T1 are significant for * $P<.005$.

DISCUSSION

Results of this study demonstrates that acute fatigue following a supramaximal run to exhaustion does not increase running economy or alter stride kinematics over the short term. However, metliodological validity must be taken in account wlien discussing this stability. Firstly, knowledge of within-subject variability in running economy and stride kinematics is necessary to evaluate the real effect of fatigue. Previous research involving trained runners have showned that, with the same methodology, these parameters can be used at assessing an experimental protocol (Brisswalter and Legros, 1994; Brisswalter et al., 1994). Secondly, in our study, the validity of $VO2$ to assess the energy demand of walking depends on the fact that the exercise was strictly aerobic (di Prampero, 1986). For the two submaximal tests, the relative oxygen consumption (expressed as percentage of max) was lower than 70%max. This result allows us to consider that, in this population, throughout the second session, exercise was strictly aerobic.

The stability in running is in agreement with the study of Morgan et al. (1990), for a 30 min maximal run and moderately trained runners and indicates that metabolic changes induces by a supramaximal run to exhaustion doest not affect . This assumption is supported by previous results showing no correlation between lactate metabolisation after a supramaximal exercise and (Rieu et al.,1988). Furthermore a supramaximal run does not affect the running gait and indicate that elite 400m runners are able to maintain the same pattern 1/2 and 1 hour after a run to exhaustion. This results are in agreement with a recent study after a marathon run who failed to observe any changes in stride kinematics despite an alteration in neuromuscular function (Nicol et al, 1991)

CONCLUSION.

These results indicate, for elite runners and after a supramaximal run, the general stability of metabolic and kinematic parameters during a submaximal run. However, the lack of variation in running pattern must be considered principally as the capacity of the subject to maintain this gait apart from the effect of fatigue. Further multidisciplinary research will be needed to clarify the nature of the relation between running economy and fatigue .

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