Nikolaos Bollas¹
Irina Juhas²
Nenad Janković²
Milan Matić²

¹High School in Seres, Greece
²University of Belgrade, Faculty of Sport and Physical Education, Serbia

THE EFFECT OF TWO TRAINING MODELS
ON THE AVERAGE CHANGES IN RUNNING SPEED
IN 2400M RACES

Abstract
Running at an even pace is, in both physical and tactical aspect, an essential factor when achieving good results in middle and long distance races. The appropriate strategy for running a tactically effective race starts by selecting the optimal running speed. Two models of training lasting for six weeks were applied on the group of subjects (N=43) composed of students from the Faculty of Sport and Physical Education, University of Belgrade. The aim of the study was to determine how the applied models of training would affect the deviations of running speed from the mean values in 2400m races when running for the best result and also, how the applied models of training would affect the improvement of aerobic capacities, showed through maximal oxygen uptake. The analysis of the obtained results showed that no statistically significant differences in the average deviations of running speed from the mean values in 2400m races were recorded in any of the experimental groups either in the initial (G1=2.44±1.74 % and G2=1±0.75 %) or the final measurements (G1=3.72±3.69 % and G2=4.57±3.63 %). Although there were no statistically significant differences after training stimulus in either final measurements, the subjects achieved better result, that is, they improved the running speed in the final (G1=4.12±0.48 m/s and G2=4.23±0.31 m/s) as compared with the initial measurement (G1=3.7±0.36 m/s and G2=3.84±0.38 m/s). The results of the study showed that in both groups, there was a statistically significant improvement in the final measurement (G1=56.05±6.91 ml/kg/min and G2=59.55±6.95 ml/kg/min) as compared to the initial measurement (G1=53.71±7.23 ml/kg/min and G2=54.58±6.49 ml/kg/min) regarding the maximal oxygen uptake so that both training models have a significant effect on this variable. The results obtained could have a significant contribution when working with students and school population, assuming that in the lessons of theory and practical teaching they are first educated and then, over a relatively extended period of time, are enabled to develop their own 'sense of space and time' with an aim to increase the efficiency of running in middle and long distance races, which in the end manifests itself through achieving better results.

Key words: ATHLETICS / MIDDLE DISTANCE / PACE

INTRODUCTION

The pace of running is closely correlated with the tactics of running a race. For each competition in any sport, the preparation also includes a tactical plan to ensure the best possible placement or victory. Practicing and applying the tactics is to be included even in the early forms of training and competitions, but in its simplest form. Later on, when the technical mastery and physical preparation have been raised to a higher level, the tactics is more important.
Running a tactically effective race can be a decisive factor in achieving the expected results and placements. The appropriate strategy begins by selecting the optimal running speed. Running middle and long distances are very popular athletic disciplines in the world. In order to be able to resist various tactical approaches, runners in middle and long distance races have to be well trained in terms of pace and have so called ‘feeling for the pace of running.’

An important feature of each tactical method is the ability of athletes to apply the appropriate tactical approach which would be useful under specific conditions and in line with the newly created circumstances (Stefanovic, 1981, 2006; Ozolin, Voronkin and Primakov, 1989).

Tactics in running middle and long distance races actually engages all available resources to fulfill a goal, whether to win, achieve a high placement or a personal best result (Fragkiadakis, Bollas and Megaloikonomu, 2003). The main prerequisite for successful running tactics is excellent physical and mental preparation, as well as good pace planning and effort regulation. Running at an even pace is characterized by minimal changes in speed throughout the race. Numerous experimental and theoretical researches have shown that even paced running implies such a movement where there are no major changes in the running speed (up to ±3%) (Homenkov, 1977, Dick 1980, Dick, 1980b; Petrovic et al., 1980, Suslov, Popov, Kulakov and Tihonov, 1982; Suslov, Maksimenko, Nikituskin, Brejzer and Tihonov, 1990, Stefanovic, 1993; Malacko and Radjo, 2004; Fratric 2006; Stefanovic, Juhas and Jankovic, 2008).

When applying tactics „to achieve results” the goal of running has to be formulated in such a way so as to run as evenly as possible avoiding any interruptions of the uniform rhythm, thus saving energy while maintaining effort and pace at any price.

Running at the same level of exertion is based on choosing the speed according to the subjective assessment of fatigue. This strategy enables a finish without too much fatigue. However, it prevents runners from achieving optimal result and is therefore more convenient for beginners. One of the main goals for a runner in 800m races is to run the first 400m at a level close to 93% of the maximal result at 400m (Vigil, 1995). The second lap of the race represents the critical point of the race. The second lap should be run at 89% of maximal speed at 400m (Vigil, 1995). Like in an 800m race, in a 1500m race the last lap is the fastest with a critical point at about 300m before the finish. Unlike an 800m race, where the first lap is faster, in a 1500m race the pace increases from lap to lap (Brown, 2005). Practicing and application of tactics should be included even in the early forms of training and competitions but in its simplest form by controlling the pace of running. Later on, the tactics can be more complex and have a greater importance when technical skill and physical preparation have been raised to a higher level. It is characteristic of every tactical method to create ability in the athletes to, complying with the newly created conditions, immediately apply the appropriate tactical approach useful under specific circumstances (Stefanovic, 1981, 2006; Ozolin, Voronkin and Primakov, 1989). „The winning” tactics is most often implemented in situations related to the qualification races or when running „to win.” If a realistic assessment says that there is no chance for winning, the best tactics a runner can apply is to do his best and run as fast as he can, hoping that he will achieve his fastest time, and to keep some reserve energy for the finish.

Influenced by training, manifestation of the physical work capacity in every athletic discipline of running in middle and long distances has a specific nature and depends on the correlation in the levels of development between aerobic and anaerobic capacities of athletes. Sports results, such as when running long distances, depend mostly on aerobic power, aerobic capacity and anaerobic glycolytic capacity. Every athletic discipline of running middle and long distances is characterized by specific completion of major metabolic factors, which show a certain influence on the level of sports achievements. According to Brdaric (1994) the relationship between aerobic and anaerobic capacity in runners at 10.000m, which was created under the influence of training has the following structure: aerobic factors account for 72.6%, while anaerobic participate with 27.4%. The greatest contribution is that of aerobic power (VO2max) - 45.63%, which enables running a 10.000m race at a high pace. The same author holds that aerobic capacity allows aerobic power to be used to the maximum in a 10.000m race. Glycolytic capacity enables a runner to change the pace during the race and in the finish at the end of the race. High aerobic power
and high glycolytic capacity allow it for the runner to fulfill entirely the tactical plan, to change the pace of running a few times during the race, as well as to finish the last 400m and even the last 1000m if needed.

Carter, Jones and Dust (1999) monitored the effect of six weeks’ endurance training on several variables, among others, on the maximal oxygen uptake and running speed at the anaerobic threshold. The experimental group consisted of subjects (N = 16) aged 23 years and average body weight of 70 kg. After the experimental program results showed a statistically significant increase in maximal oxygen uptake from 47.9 to 52.2 mlO₂/kg/min and in running speed at the anaerobic threshold from 13.3 to 13.9 km/h.

Positive pace tactics is characterized by gradual reduction of the running speed during the race. Studies have revealed that top runners in 800m races, for the first 200m of the run, run at a speed of 107.4% of the average in 800m. For the following 400m the speed is at 98.3% and for the last 200m it is at 97.5%. Compared with the tactics of running at the same pace, this tactics also showed a higher friction peak of oxygen uptake (89.3 ± 2.4% vs. 92.5 ± 3.1% VO₂max, respectively) (Sandal et al, 2005). This tactic proved to be relatively successful; however, only occasionally. Due to fatigue, there is a decline in speed, and at the end of the race there are registers of higher lactate levels, increased respiratory gas exchange and subjective feeling of exertion compared to the tactics of running at the same speed (Abbis & Laursen, 2008).

The case studies of the world record set by Gebrselassie and ultramarathon in Sidney showed a great variability regarding tactics of speed at the microscopic level (Angus & Waterhouse, 2011). A research on 10.000m treadmill race and in real conditions has shown that runners of higher and lower level use different tactics in running 10.000m races. Important determinants when choosing the speed tactics which significantly correlate with the speed at the start, in the middle and at the end of the race at 10.000m include the maximal running speed, running economy and lactate threshold (Lima-Silva et al, 2010).

In accordance with the past scientific researches with similar topics and objectives, the goal of the research was to determine how the two training models of running would influence the manifestation of deviations in the running speed from the mean value in a 2400m run when running for the best result and whether the applied models of training would have an impact on the improvement of VO₂max.

METHOD

Sample of subjects

The sample of subjects consisted of students from the Faculty of Sport and Physical Education, University of Belgrade, who have volunteered to perform the experimental procedure. The total number of subjects in the initial and final measurement was N = 43. The subjects were male, aged 21-22 years, and may be described as averagely-trained people. Prior to joining the experiment, they were informed about the essence of the experiment. The subjects were divided into two experimental groups:

- the first experimental group (G1) where the applied model of training was that the participants were not given information about the lap times at every 400m, but only after completing the whole distance and,
- the second experimental group (G2) where the applied model of training was that the participants received information about the lap times at every 400m.

Sample of the variables

The sample of the variables consisted of: the average running speed at 2400m - v₉₀ (m/s), the average change in running speed at every 400m from the mean value of 2400m run expressed in percentage and maximal oxygen uptake - VO₂max (ml/kg/min).

Experimental protocol

A training program with the use of the Interval training method was planned for conducting this experiment (Stefanovic et al. 1984; Stefanovic, 1992; Tonchev, 1993, Tomash and Djordjevic, 1996; Bollas, 2004). The experiment lasted for six weeks, or 18 training sessions. The subjects of both experimental groups were trying to achieve the best possible results in the race in the initial and final measurements, with the least oscillation in the running speed. The men-
tioned experimental curriculum was implemented during practical lessons (one lesson of training three times a week) of Theory and Methodology of Athletics at the Faculty of Sport and Physical Education in Belgrade, on the athletic track of the stadium in Kosutnjak Sports Center. The measurement of functional abilities was performed in the morning hours in the Methodological Research Laboratory of the Faculty of Sport and Physical Education in Belgrade. Before the initial measurement of the results in running a distance of 2400m, all subjects were tested by Astrand test, in order to create homogeneous groups.

The time (t) for 2400 m distance was measured; the average running speed (v_r) and the average change of speed from the mean value (%) were calculated for all the subjects in the initial and final measurements. During the experiment, the subjects were trying to run at an even pace, i.e. to achieve the least average changes of the running speed from the mean value, or to create a sense of effective pace of running.

Assessment of maximal aerobic capacity, or maximal oxygen uptake (VO_{2max}) was performed by using Astrand test (Astrand & Rodahl, 1986), and the results are expressed in ml / kg / min. 2400m runs were organized according to the athletic rules (2009) on the athletic track.

**Data Analysis**

After completing the experiment, the obtained data were statistically analyzed. Representative measures of average values and standard deviations were used in the area of descriptive statistics. In order to determine the effects of training on the monitored variables, an analysis of variance with repeated measurements was performed (the initial and final measurements) in relation to the two groups (G1 and G2) – a combined analysis of variance.

In case when the subsequent data processing showed a significant effect of the key factors (time and group), as well as the interaction of time and group, then we did an analysis of simple impact of training (time) on each group separately. Identification of differences between the various levels of one factor was performed based on the Bonferroni Post Hoc analysis. The effect of the statistical significance was defined at the level of n value which was set to the value of ≤ 0.05.

**RESULTS AND DISCUSSION**

Table 1 shows the values of average running speed (m/s) and standard deviations in the initial and final measurements for both groups of subject.

<table>
<thead>
<tr>
<th>Group</th>
<th>Measurement</th>
<th>v_r (m/s)</th>
<th>SD</th>
</tr>
</thead>
<tbody>
<tr>
<td>G1</td>
<td>Initial</td>
<td>3.70</td>
<td>.36</td>
</tr>
<tr>
<td></td>
<td>Final</td>
<td>4.12</td>
<td>.48</td>
</tr>
<tr>
<td>G2</td>
<td>Initial</td>
<td>3.84</td>
<td>.38</td>
</tr>
<tr>
<td></td>
<td>Final</td>
<td>4.23</td>
<td>.31</td>
</tr>
</tbody>
</table>

Applying a combined analysis of variance, Table 2 represents the impact of the training period (time) and the impact of group on the average speed variable for the two groups of subjects (G1 – the first group, G2 – the second group).

<table>
<thead>
<tr>
<th>Among the same subjects</th>
<th>F</th>
<th>Sig.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Time</td>
<td>123.84</td>
<td>.000</td>
</tr>
<tr>
<td>Time*group</td>
<td>.205</td>
<td>.653</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Among different subjects</th>
<th>F</th>
<th>Sig.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Group 1 and 2</td>
<td>1.138</td>
<td>.292</td>
</tr>
</tbody>
</table>

The obtained results show that both groups improved the time significantly at the end of the race in the final compared to the initial measurement. Bonferroni Post Hoc analysis found that there were no differences in the obtained results among the different groups of subjects.

Pictures 1 and 2 illustrate the values of average deviations from the mean running speed in 2400m race in the initial and final measurements for both groups of subjects (G1 and G2).
Table 3 Descriptive analysis results of deviations from the mean running speed at every 400m in 2400m race in the initial and final measurement

<table>
<thead>
<tr>
<th>Deviations from the running speed at every 400m</th>
<th>0</th>
<th>400</th>
<th>800</th>
<th>1200</th>
<th>1600</th>
<th>2000</th>
<th>2400</th>
</tr>
</thead>
<tbody>
<tr>
<td>Measurement</td>
<td>M</td>
<td>SD</td>
<td>M</td>
<td>SD</td>
<td>M</td>
<td>SD</td>
<td>M</td>
</tr>
<tr>
<td>G1 Initial</td>
<td>3.09</td>
<td>1.84</td>
<td>1.74</td>
<td>1.12</td>
<td>2.72</td>
<td>2.13</td>
<td>2.01</td>
</tr>
<tr>
<td>G1 Final</td>
<td>6.59</td>
<td>6.35</td>
<td>2.21</td>
<td>1.44</td>
<td>4.10</td>
<td>7.15</td>
<td>2.24</td>
</tr>
<tr>
<td>G2 Initial</td>
<td>1.33</td>
<td>1.11</td>
<td>0.65</td>
<td>0.41</td>
<td>0.66</td>
<td>0.52</td>
<td>1.15</td>
</tr>
<tr>
<td>G2 Final</td>
<td>8.72</td>
<td>6.38</td>
<td>3.5</td>
<td>3.07</td>
<td>3.13</td>
<td>2.68</td>
<td>3.11</td>
</tr>
</tbody>
</table>

Table 4 The effect of variable among the same subjects

<table>
<thead>
<tr>
<th>Distance (m)</th>
<th>0-400</th>
<th>400-800</th>
<th>800-1200</th>
<th>1200-1600</th>
<th>1600-2000</th>
<th>2000-2400</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>F</td>
<td>Sig.</td>
<td>F</td>
<td>Sig.</td>
<td>F</td>
<td>Sig.</td>
</tr>
<tr>
<td>time</td>
<td>29.96</td>
<td>.000</td>
<td>16.22</td>
<td>.000</td>
<td>4.72</td>
<td>.036</td>
</tr>
<tr>
<td>time*group</td>
<td>3.69</td>
<td>.06</td>
<td>8.36</td>
<td>.006</td>
<td>.381</td>
<td>.541</td>
</tr>
</tbody>
</table>

Table 5 The effect of variable among the different subjects

<table>
<thead>
<tr>
<th>Distance (m)</th>
<th>0-400</th>
<th>400-800</th>
<th>800-1200</th>
<th>1200-1600</th>
<th>1600-2000</th>
<th>2000-2400</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>F</td>
<td>Sig.</td>
<td>F</td>
<td>Sig.</td>
<td>F</td>
<td>Sig.</td>
</tr>
<tr>
<td>Group 1 and 2</td>
<td>.03</td>
<td>.86</td>
<td>.07</td>
<td>.8</td>
<td>3.72</td>
<td>.06</td>
</tr>
</tbody>
</table>
Upon completing the experiment, the results of the research showed that the training model which implied that the subjects were not given information about the lap times every 400 m, but only after completing the distance, had no significant effect on reducing the variability of the running speed deviations in 2400m race in the first experimental group. The training model which implied that the subjects received information about lap times every 400m had no significant effect on reducing the variability of the running speed deviations in 2400m race in the second experimental group.

The descriptive analysis results for the variable of maximal oxygen uptake in the initial and final measurements are given Table 7, whereas the combined analysis results of the variance which tested the impact of the training period (time) and the impact of the group of subjects are given in Tables 8 and 9.

Table 7. Values of maximal oxygen uptake in the initial and final measurements

<table>
<thead>
<tr>
<th></th>
<th>Group</th>
<th>M</th>
<th>SD</th>
<th>N</th>
</tr>
</thead>
<tbody>
<tr>
<td>Initial</td>
<td>G1</td>
<td>53.71</td>
<td>7.23</td>
<td>19</td>
</tr>
<tr>
<td></td>
<td>G2</td>
<td>54.58</td>
<td>6.49</td>
<td>24</td>
</tr>
<tr>
<td>Final</td>
<td>G1</td>
<td>56.05</td>
<td>6.91</td>
<td>19</td>
</tr>
<tr>
<td></td>
<td>G2</td>
<td>59.55</td>
<td>6.95</td>
<td>24</td>
</tr>
</tbody>
</table>

The results show that with both groups there is a statistically significant improvement in oxygen uptake, so that both training models had a considerable effect on this variable. Since an interaction of time and group was identified, an analysis of simple impacts was performed so that the effect of time or the training period would be examined for each of the experimental groups. The training model of group G2 affected statistically significant increase in oxygen uptake measured by Astrand test, in contrast to the training model used by group G1, where a statistically significant improvement in this variable was also found, but with a slightly reduced intensity of the changes as compared to the changes recorded in group G2. This can be attributed to the fact that
the control and regulation of the intensity were more efficient when the subjects had a feedback about the lap speed. It is assumed that this led to better adaptation of the cardiovascular system which was achieved through better control of the running pace.

According to the achieved results it can be concluded that both groups significantly increased the average deviation from the average running speed in the final compared to the initial measurement. This can be attributed to the fact that both groups of subjects having achieved a higher running speed had a significant effect on a greater variability in the average change in the running speed. It is assumed that they did not have enough experience as professional runners which would enable them to improve the pace of running as well.

CONCLUSION

Given that the average change of speed plays a vital role in running middle and long distance races, this research was aimed to find out how averagely trained subjects, upon receiving the training stimulus, would behave during a 2400 m race when running for the „best result.”

The analysis of the obtained results showed that as for the average deviations in the running speed at every 400 m from the mean running speed during a 2400 m race, the both experimental groups had approximately the same values in the initial and final measurements. Although no statistically significant differences were recorded, upon receiving the training stimulus in both final measurements, the subjects performed better, that is, they improved the running speed. Upon completion of the experimental work, the research results with the first experimental group showed that the training model which implied that the subjects were not given information about the lap times at every 400 m, but only after the completed distance, had no significant effect on reducing the variability of deviations in the running speed in 2400 m race. The training model which implied that the subjects received information about the lap times at every 400 m had no significant effect reducing the variability of deviations in the running speed in 2400 m race in the second experimental group. Both experimental groups of subjects significantly improved results in the functional area (maximal oxygen uptake).

The results of the research found a practical application in training and evaluation of male students in running 2400 m race in practical teaching of academic subject Theory and Methodology of Athletics at the Faculty of Sport and Physical Education, University of Belgrade.

The findings of the research could have a significant scientific and professional contribution to the development of athletic theory and practice among students and school population, assuming that the lessons of theory and practical teaching of athletics first educate the students and then, over a relatively extended period of time, enable them to develop their own ‘sense of space and time’ in running middle and long distance races, with an aim to increase the efficiency of running which, in the end, manifests itself through achieving better results. The obtained results could, to a certain extent, help improve the knowledge in the field of running tactics, i.e. the optimization of running pace in middle and long distance races with the aim to achieve better results.

REFERENCES


Zusammenfassung


Schlüsselwörter: ATHLETIK / MITTELSTRECKE / TEMPO

Received: 27.03.2014.
Accepted: 05.05.2014.