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The analysis of the pacing profiles based on performance level of the male finishers in the istanbul marathon

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Abstract
The aim of this study was to determine, on the basis of performance levels, running pace profiles of the male runners (n = 2095) who completed the 40th International Istanbul Marathon in less than 6 hours. While 0-35 km of the marathon was divided into 5 km long sections, 35-42.2 km of it was determined as the last segment which was 7.2 km. The average speeds of the running pace of the athletes in the determined segments were calculated. Performance groups were evaluated in 8 different groups with the athletes completing the race in the finishing time slower than the winner's race time. In these context, the independent variables were performance levels and the segments, dependent variable was mean running times in all these segments. The difference between performance groups and successive segments was evaluated with Two-way repeated measures ANOVA. The results also showed that mean pacing alterations between successive segments throughout the race had some similarities and were correlated between the performance levels. Analysis showed that there were statistically significant alterations between successive segments pacing profiles depending on for each performance levels ($p<0.000$). Overall, the athletes showed an increasing pace in all the performance groups in the first 10 kilometers of the race ($p<0.001$). The highest level of the performance group showed an even pace in the segments between 10 and 25 km, while it fell between 25 and 30 km and continue at this level between 30 and 35 km. In other groups, it was observed that the speeds fell inversely proportional to the performance in the segments between 10 and 35 km ($p<0.05$). In the last 7.2 km segment, it was observed that the athletes with the highest level of performance had a decrease in pace and the rate of decrease in the pace was lower in the groups with lower performance level. Only in the slowest group of athletes, the pace was observed to increase in the last segment. Considering the whole race, it was seen that the athletes showed a pace profile close to the positive pace profile in general.
Keywords: endurance running, race strategies, pacing, speed, running

INTRODUCTION

The best running pacing strategy during middle and long-distance running races and the control of this strategy throughout the race play an important role in an athlete's ability to complete the race in the best time by maintaining the physiological reserve (5). Therefore, an athlete should avoid wasting kinetic energy and should use all energy stores before finishing the race. Yet consuming all the existing energy resources while there is a long distance to the finish line might cause a significant decrease in the running pace (9). In such a case, the muscle glycogen or blood glucose level (or both) decrease significantly before the finish and it causes a sharp decrease in the pace. The opposite of this is the case where the athlete leaves too much reserve at the end of the race. The athlete's passing the finish line with loaded energy stores and strength is the result of an error in the pacing strategy he/she follows during the race (10). That is to say, a runner who follows an extremely low pace with a fast-finishing strategy might finish the race with a poor performance despite speeding at the end of the race (33).

When the studies in the literature are analyzed through a physiological perspective, there are studies stating that during an 800m run, the VO^2 values of the elite middle distance runners were higher with the positive racing strategies with fast-starting compared to the even pace (30). The all-out

pacing strategy with fast starting in the two-minute canoe ergometer performance was shown to be more effective than the even pacing strategy, although speed and VO^2 declined steadily (4). The declines in speed and VO^2 in the last 100m of the middle distance 400 and 800m races are similar to the aforementioned results (16). It is stated that fast-starting strategies between 4-12 minutes at maximal running speed cause positive effects such as longer distance and exercise duration by forcing the adaptation of oxygen transport system and intracellular oxidation metabolism and ensuring higher VO^2 and lower metabolic acidosis values (37). In addition, the similarity of blood lactate and Ph values in slow, even and fast-starting strategies reveals that pacing strategies do not affect some physiological parameters (2).

While elite runners can sometimes run more slowly than their ideal pace as a strategy, some runners at lower levels can push themselves to run faster than their own pace to avoid fall behind the front group. However, this may lead to earlier fatigue and steady decrease in pace (34). In addition, for an athlete to maintain his/her predetermined pacing strategy, internal factors such as the existing energy stores, hydration level, neuromuscular fatigue, cardiorespiratory performance, external factors such as the convenience of the race track and environmental conditions and also decision-making processes such as psychological readiness, mental competence, tactical changes, effort perception, nationality, psycho-biological status, and behavioral characteristics play an important role (3,8,13,25,26,28,36). Therefore, it is stated that it is more appropriate to use the concept of pace profile instead of pacing strategy in studies related to pace profiles (31).

The marathon has recently become one of the most popular events for long-distance runners, both in the World and Turkey. Although running pace has an important role in optimizing the individual performances of runners, research results regarding the race running pace profiles related to the marathon races at the national level have not been found (19,21,31). It is clear that Istanbul Marathon, which is one of the most important and longest-running sports organizations in Turkey, has an important value for this kind of research. The organization, which started in 1979 with the name of Asia-Europe run and a small group of athletes, took the name of Intercontinental Istanbul Eurasia Marathon in 2013 and then the name of İstanbul Marathon (17). Over 28,000 registered participants participated in this big organization arranged for the 40th time in 2018, and Felix Kimutai won by setting a 2:09:57 track record (18).

IAAF and Olympic marathon medalist male athletes had even strategy with negative splits and end-spurt, slower athletes had positive strategy with end-spurt (14). On the other hand, in the city marathons, the male finishers who completed the New York Marathon showed more even strategy, besides that fastest athletes finished the races without end-spurt but slower ones finished with end-spurt. The authors stated that excessive fast start may cause a decrease in speed in the second part of the race (23, 31). Fast finishers (both sexes) in Major marathons like Chicago, London and New York maintain a more constant pacing than the slower ones (19). According to these results, there may be different pacing profiles between Olympic and city marathons, but also some pacing differences can be seen between elite and non-elite athletes. Therefore, in this study, it is thought that focusing on a specific marathon may be useful for athletes in determining race pace strategies on the basis of achievable goals suitable for their performances. Accordingly, the aim of this research was to describe the basic running pace profiles on the basis of the performance levels of male runners who completed the 40th Istanbul Marathon organized in 2018.

MATERIAL & METHOD

In this observational study conducted to define race pace profiles, the data of the 40th Vodafone Istanbul Marathon held in 2018 were used. Permission has been asked from Istanbul Metropolitan Municipality Sports Inc., which is the race organizer, for the scientific use of the data publicly accessible from the official website of the organization (18).

Participants

For the analysis of the data, the marathon times of the athletes who participated in this marathon and finished in 6 hours and less were used. The marathon times were based on the times of the athletes' passing the starting and finish lines of the race. The athletes with a total race time of more than 6 hours and those with a change rate of

more than 30% in the successive inter-segments average pace were not included in the study due to the possibilities of intolerable fatigue, disability or quitting the run. Since the number of women who finished the race (n=266) was about 10% of the number of men (n=2592), only the data of the male athletes were included in the study. Among 2592 male athletes who completed the Istanbul Marathon, only those who were matching the determined inclusion criteria were included in this study (n=2095).

Data Collection

Because of the speed is more symmetrical, normally distributed and linearly correlated with other data, the race times were converted to average running speeds for 8 equal splits of the race (min/km) (22,27). Race paces (min/km) were analyzed in a total of 8 segments consisting of 5 km parts (0-5 km, 5-10km, 10-15 km, 15-20 km, 20-25 km, 25-30 km, 30-35 km) and in addition to the last 35-42.2 km part of the race. Running times (min/km) of these separate splits were included in the analysis.

Data Analysis

Performance groups of the athletes were evaluated on the basis of the finishing time according to the winner's time. In other words, on the basis of the performance all athletes were divided into 8 different groups consisting of the athletes who finished with a time were less than 20% slower than winner's time (Perf-1 group), athletes whose finishing times were 21 to 40% slower than the winner's time (Perf-2 group), 41 to 60% (Perf-3 group), 61 to 80% (Perf-4 group), 81 to 100% (Perf-5 group), 101 to 120% (Perf-6 group), 121 to 140% (Perf-7 group), and more than 141% (Perf-8 group) slower than the winner's finish time of the race (11,12,13,14).

Statistical Analysis

All the data were given as average and standard deviation. The data in Normal Q-Q Plot and De-trended Q-Q Plot Graphs showed normal distribution. Runners with extreme values (n= 143) were identified with the box graphics and their data were not included in the analysis. Marathon transition periods were evaluated as a group. In these context, the independent variables were performance levels and the segments, dependent variable was mean running times in each segments. Two-way repeated measures ANOVA was used in repetitive measurements in order to determine both the difference in pace changes between segments and the difference between the groups for the same segment. Mauchly sphericity test was used to determine the variance and covariance equality, and Greenhouse-Geisser correction was used when this assumption was not provided. Effect size was determined with partial eta square. The level of statistical significance was set at $p<0.05$. A suitable one of Tukey and Games-Howell post-hoc tests (the one which is suitable for non-equilibrium variants) was used in order to determine in between which two values the significant difference identified in ANOVA test is. SPSS v.20 software was used for all statistical calculations.

RESULTS

Running pace averages determined as the average km running time (in every segment) of the athletes in the performance groups are given in Table 1.

Table 1. Descriptive statistics related to average segment pace of the performance groups (min:sec)

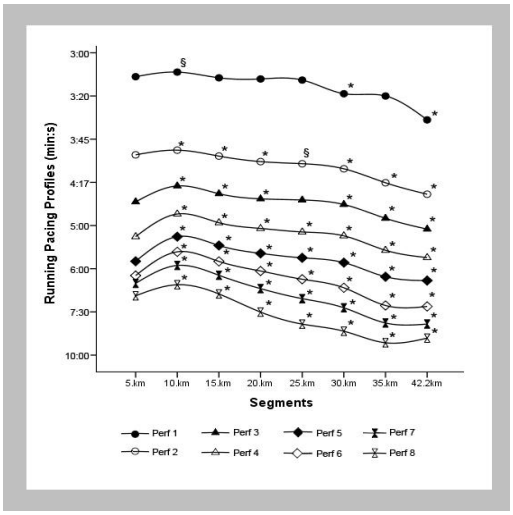
	N	5.km	10.km	15.km	20.km	25.km	30.km	35.km	42.2km
Perf 1	19	03:10±12	03:11±10	03:13±11	03:13±12	03:14±12	03:19±13	03:21±16	03:34±09
Perf 2	51	03:57±14	03:52±12	03:57±13	04:00±12	04:01±11	04:05±10	04:18±13	04:29±05
Perf 3	186	04:36±22	04:21±12	04:28±12	04:32±13	04:34±12	04:39±12	04:53±17	05:06±03
Perf 4	416	05:16±26	04:49±15	04:58±14	05:04±13	05:08±13	05:13±14	05:33±22	05:45±02
Perf 5	480	05:50±31	05:15±19	05:26±16	05:36±17	05:43±16	05:52±19	06:17±29	06:25±02
Perf 6	423	06:14±32	05:36±22	05:49±20	06:04±20	06:19±22	06:36±24	07:16±34	07:22±02
Perf 7	283	06:30±34	05:56±26	06:13±22	06:38±24	07:00±25	07:20±27	08:05±35	08:06±02
Perf 8	237	06:56±40	05:00±31	06:51±29	07:33±31	08:06±31	08:29±34	09:10±39	08:53±02

(Mean±Standard deviation)

Two-way repeated measures ANOVA analysis showed that there were similarities between the performance levels in average pace in successive segments. Accordingly, it can be said that pacing profiles are correlated with throughout the race, in other words there is a similarity in the pace profiles based on the performance levels (Figure 1). As seen in Figure 1, the pace in the segment between 5 and 10km shows a significant increase in all performance groups. In the following segments, it is seen that the paces show a significant decrease in the performance groups in general, except for the Perf 1 group, until the last segment (p<0.05). In the Perf 1 performance group, it is seen that there is a more even pace in between 10-25 km and a decrease at a certain ratio in between 25-30 km (p<0.05), and that this pace remains unchanged in the segment between 30-35 km. In the last segment, while the pace shows significant decreases in all the performance groups, it is seen that there is an increase in the 8th group (p<0.001).

According to the Tukey Post-hoc multiple comparison results it was seen that there was a statistically significant difference between all successive segments (p<0.05). It was seen that according to the results of simple basic effects for the segments, there were statistically significant differences between the successive segments. It was seen that according to the Tukey Post-hoc multiple comparison results, there were significant differences in the successive inter-segments running pace (p<0.05) (Figure 1).

Figure 1. The differences in the successive inter-segments average pace times of the athletes in the performance groups p<0.05 (§), p≤0.001 (*).



DISCUSSION

The aim of this study was to define the race pace profiles of the male athletes participating in the Istanbul Marathon and to compare the pace profiles of the athletes at different performance levels. According to the findings, it was seen that there were statistically significant differences in the running pace profiles based on the performance levels. However, some similarities were observed in the pace profiles. For example, although it was in varying proportions, it was seen that the pace increased in the 5-10 km segment in all performance groups and then it decreased except for the 1st group. In the first performance group, they showed more even pace profiles until the 25-30th km segment. Again in the first group, it was seen that there was a decrease in the pace in the 30-35 km segment, in the next segment, this pace level was maintained and in the last 7.2 km of the race there was a decrease again. This means that the pace profiles of the elite athletes in the Istanbul Marathon track were ranging relatively more balanced and at the last part of the race, there was no pace increase which could be defined as end-spurt. While this profile might be a tactic for elite runners, it also suggests that it might be due to the interaction of the front group in the race or the structure of the track, because construction and environment interactions such as weather conditions, hypoxic conditions, air temperature may affect the pace (7,29,32,35,20). There was an upward slope on the last one kilometer of the Istanbul Marathon, where there was no slope except for the first and last parts of the race. The end-spurt was not seen in any group except for the 8th performance group. The end-spurt in this performance group points to the fact that during the race the athletes at this performance maintained their energy stores highly and insufficient potential use in terms of using energy stores in an even way throughout the race.

Except for the first segments of the race, it was observed that the running pace of the lower performance groups decreased gradually and showed a pace profile closer to the positive pacing strategy. It is noteworthy that the race was at the fastest pace for all the performance groups in the first segments, especially between 5-10 km. Male and female cross-country athletes' showing a positive pace profile with a fast-starting (15) bears a resemblance to the results of this study. While the male athletes who won medals in the IAAF and

Olympic marathons showed an even pacing strategy with negative split and end-spurt, the athletes with longer finishing times compared to the medal winners showed a positive pacing strategy with end-spurt at varying rates based on the performance levels (14). It was seen that the pace profiles of the athletes with 5% and longer finishing times compared to the IAAF and Olympic marathon medal winners were similar in the pace profiles of the male runners participating in the Istanbul Marathon. While male runners competing in the Athens classic (24), the New York Marathon (23,31) and in other major marathons (19) showed a more even pace profile, the fact that there are also similarities between the pace profiles, based on the performance level, of the male runners competing in the New York Marathon (31) and the pace profiles of the runners competing in the İstanbul Marathon suggests that there are some common points between the pace profiles of elite, sub-elite and recreational runners participating in the İstanbul marathon and the pace profiles of the runners of some city marathons.

When looking at the race in general, it can be said that the running pace profiles for all the performance groups were close to the positive pacing strategy which tended to accelerate relatively in the first segments of the race. It is stated that during a race, the acceleration time can significantly affect the pacing strategy especially in short-distance races (1). In positive pacing strategies, the accumulation of metabolites that cause fatigue with increases in oxygen consumption causes fatigue feeling to increase in the first parts of the race (1). The segments with acceleration in the first parts of the race in the Istanbul Marathon suggest that the pace decreased due to physiological fatigue in the following parts and thus this caused a positive pace profile. At this point, if athletes integrate training that includes adaptation to pacing strategies specific to the start and the first parts of the race in their programs, it would have positive impacts on optimizing and applying pacing strategies.

While the pace profiles of the runners with Marathon World record showed a positive structure in the past years, in more current records, in the last 5 kilometers of this race, which was the fastest part, they began to change towards negative profiles. However, strategies characterized by minimum speed changes are indicated to be the most effective pacing strategies (6). From this point of view, differentiation of the results of this research from the pace profiles shows that the İstanbul Marathon is open to change and development in terms of pace profiles and pacing strategies. In addition to all these, it is emphasized that long-distance runners competing for medal goal must run as close as possible to the group leading the race from the beginning to the end of the it (8).

CONCLUSION

In conclusion, according to the results of this study, the pace profiles of the male runners at different performance levels competing in the Istanbul Marathon showed mostly a positive pacing strategy feature with a relatively fast-starting. In positive strategy, the speed of the athlete gradually decreases throughout the race (1). While a similar pace profile in the elite runners also included a positive pace profile with relatively less pace declines, there was no end-spurt in any group except for the 8th performance group. It is possible to interpret this situation with the relatively overloaded energy stores resulting from inadequacies in distributing energy to the whole race. As for the pace profiles, it would not be wrong to say that the runners participating in this race did not follow a distinct strategy in general.

Trainers' and athletes' taking into account the features of the pacing strategies and pace profiles specific to the Istanbul Marathon event would contribute positively to performances. However, while there might be environmental factors such as weather conditions, oxygen level and humidity (29,35), there are also many factors such as kinetic, biomechanical and physical or mental fatigue before the race (32), affecting an athlete's performance in a big and challenging race like marathon. In this study, these factors were evaluated as the limitations of the study as uncontrollable factors. In addition, the results of this study showed that the characteristics of different race tracks and the participant group could affect the pacing strategies. Thus, in future studies it is possible to compare pacing strategies between specific city marathons or pacing strategies of same athletes in different races.

Considering that this research was designed to provide results that were focused on a particular marathon activity, this research will be a resource for trainers and sports professionals to use in their programming aimed at developing pacing strategies in athletes' training or try runs. This study will be a

source in the literature for different and more holistic future studies to reveal cause and effect relation and for runners to get information about how to distribute their energies evenly to the whole race during important marathon races and about consuming the remaining energy stores entirely with end-spurt at the right time in the last part of the race.

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