Original Article (short paper)

The sex differences in the 10,000 m race strategy

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Associate Editor: Eduardo Lusa Cadore. UFRGS/Porto Alegre, RS, Brasil.

Abstract – aim: This study aimed to compare the running strategy between men and women in the 10,000 m race. **Methods:** Data from one-hundred and twenty-nine athletes who competed the 10,000 m final of the 2015, 2017 and 2019 world championship were grouped according to gender: 1) male group (n= 63; age= 25.9±4.4), and 2) female group (n= 66; age= 27.3±4.8). The running strategy was determined by assessing velocity over each kilometer. The velocity was calculated from the times available on the official website of the International Athletics Federation. **Results:** Men decreased running velocity after the first kilometer and kept the speed stable until km 9 and the kilometer 10 was greater when compared with 6-9 kilometer, while women increase running velocity until km 2 and kept the speed stable until km 9. The kilometer 10 velocity was greater when compared with 1-9 kilometer. (p< 0.001). In addition, women showed a greater average velocity variation when compared to men (p< 0.001). **Conclusion:** Our findings show a sex differences in the 10,000 m race strategy between world-class.

Keywords: athletics, pace, velocity.

Introduction

The running strategy has been considered as an important factor for the success in long-distance races[1,2], especially among high-level runners. Running strategy allows a better distribution of the energy expenditure associated with the best pace and to maintain an energy reserve for the end of race[3]. Otherwise, fatigue may be installed in the final kilometers, impairing race results[4]. Four types of running strategies have been proposed: 1) even-shaped pacing, 2) negative-shaped pacing, 3) positive-shaped pacing, and 4) parabolic-shaped pacing[3]. There is no consensus on the optimal running strategy for long-distance runners. Running strategy is a complex phenomenon that involves many personal variables, such as the level of physiological and psychological capacity[5]. The best strategy is one that allows you to complete the race in the shortest time and fatigue possible[5,6].

In addition, studies investigating the difference between the sexes on long-distance 10,000 m running strategy seem to be scarce, and only one study appears to have evaluated this topic. A previous study has shown that women maintained a constant velocity in the last 10 km of the marathon, while it was slightly reduced in men[7]. According to the authors, women have better control over running strategy in comparison to men. Besides obvious physical and physiological differences (e.g., VO_{2max}, body mass, height, etc.), other factors may be related to sex differences in the running strategy, such as exercise metabolism and psychological parameters (e.g., anxiety, motivation, etc.,)[8-11]. Glycogen and fat metabolism might be associated with the capacity to maintain a stable running pace. A previous study evaluated the oxidative metabolism during endurance exercise at a similar relative intensity in both genders[8]. It was observed a lower respiratory exchange ratio in women when compared to men. Women also tend to oxidize more fat and fewer carbohydrates, thus saving glycogen[8]. In addition, it seems that female has a higher percentage of type I fibers in comparison to men which contributes to optimizing the fat use as an energy source[9]. Previous studies involving athletes of several sports have also reported gender differences in psychological aspects. Men seem to be more aggressive, competitive, and dominant, while women are more organized, goal-oriented, more respectful to the rules, and anxious[10,11]. Considering that psychological drives are known to alter the self-paced exercise[12], it is reasonable to assume that mental state may affect running strategy.

Although a previous study has shown differences in running strategy between men and women during a marathon[7], studies on the differences between the sexes in other long-distance races, such as the 10,000 m, are lacking. Race, like the marathon, is very long and a sport that is more difficult to perform and therefore tend to have fewer participants, minimizing the ecological validity of study results. The 10,000 m race is an event more popular among amateur athletes because it has a distance more compatible with the different training levels of runners[13]. Therefore, the study aimed to compare the race strategy between men and women in the 10,000 m track and field race.

Based on the differences between the sexes mentioned earlier and considering that a proper running pace is the result of the integration of physiological and psychological drives[12], it was hypothesized that the running strategy throughout the 10,000 m race will be different between men and women.

Methods

Subjects

Disponible data from world-class runners who completed the 10,000 m World Championship the of last three competitions (2015, 2017, and 2019 years) were analyzed (n= 63 men; n= 66 women). The races that took place on the date and local time are shown in Table 1:

Table 1 - The races took place on the date and local time

City/ year	Date	The start time of the race
Beijing, 2015	August, 22 August, 24	Men: 8:50 pm (n= 23) Women: 9:10 pm (n= 24)
London, 2017	August, 4 August, 5	Men: 9:20 pm (n= 22) Women: 9:10 pm (n= 22)
Qatar, 2019	October 6 September, 28	Men: 8:00 pm (n=18) Women: 9:10 pm (n= 20)

Experimental design and procedures

The 10,000 m split time of each athlete was extracted from the International Association Athletics Federation website (IAAF)[14]. To assess the differences between the sexes on race strategy, the participants were divided into two groups. The mean age of 27.3±4.8 and 25.9±4.4 years old, for women and men, respectively. The running velocity of each kilometer was calculated by the ratio between the distance covered (1 km) and the time taken to cover it (h). The general variation of running velocity was also calculated by the percentual difference between the current and the previous kilometer. Thereafter, the general variation of running velocity was calculated by the mean of the velocity variation in each kilometer.

Statistical analysis

Data were presented as mean and standard deviation. The Shapiro-Wilk and Levenne test showed normality and homogeneity of the data, respectively. One-way ANOVA with repeated measurements was used to analyze the running velocity throughout the 10,000 m race in each group. When significant differences were found, Bonferroni's *post hoc* test was used. The ANOVA two way was used to analyze the running velocity (partials) among the championships. The general variation of running velocity between groups was compared using the independent t-test Significance level was set at $P < 0.05$. Cohen's d was used to calculate the effect size between the partials.

Results

The ANOVA did not indicate any statistical difference in the partials distribution among the competition, both for the male ($F= 1.86$; $p= 0.18$) and female groups ($F= 1.94$; $p= 0.16$). Figure 1 shows running velocity throughout the 10,000 m race in the male and female groups.

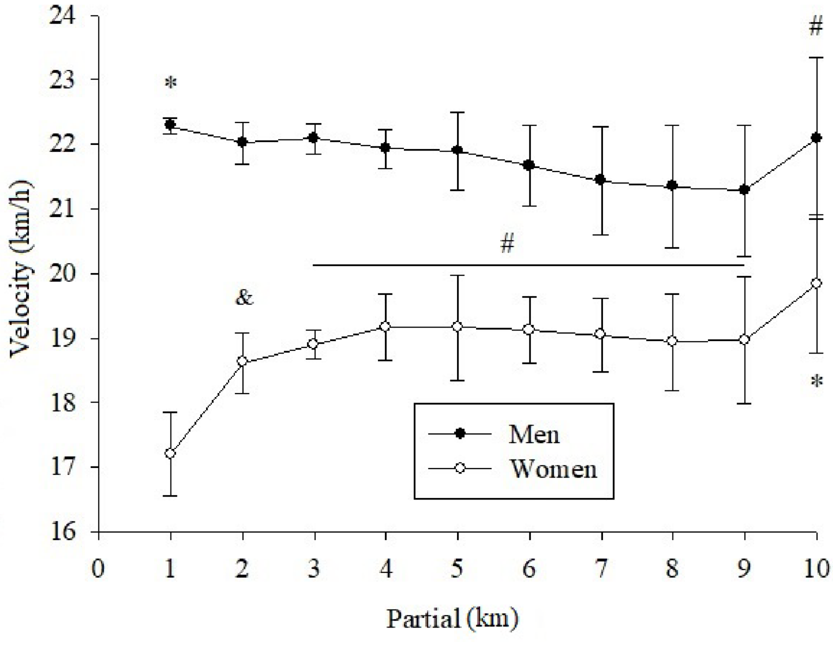

Figure 1 - Running velocity from male and female groups during **the 10,000 m race.**
Male: (*) greater than 4, 5, 6, 7, 8, and 9 km. (#) higher than 6, 7, 8, and 9 km. Female: (*) greater than 1-9 km. (#) greater than 1 and 2 km. (&) greater than 1 km.

Running velocity changed throughout race in both groups (Male: F = 22.42, $p < 0.001$, 1-β= 0.97; and Female: F= 85.1, $p < 0.001$, 1-β= 1.0). The male group decreased running velocity after the first kilometer and kept the speed stable until km 9, while the kilometer 10 was greater when compared with 6-9 km. Regarding the female group, there was a gradual increase in running velocity until km 2 and the speed was kept stable until km 9, while the kilometer 10 was greater when compared with 1-9 km. The partial effect size values for each group are present in Table 2.

Figure 2 shows the general variation of running velocity in the male and female groups. The female group showed greater variation of running velocity (0.29±0.76) when compared to the male group (-0.02±0.76) (t= -7.68, $p < 0.001$, 1-β= 1,0; d= 0.4).

Table 2 - Partial effect size in the male e female group

	Partials									
	1	2	3	4	5	6	7	8	9	10
Male	-0.93	0.22	-0.57	-0.06	-0.38	-0.31	-0.10	-0.07	0.67	-0.93
Female	1.56	0.71	0.63	-0.02	-0.05	-0.17	-0.19	0.04	0.82	1.56
Difference	2.49	0.49	1.2	0.04	0.33	0.14	-0.09	0.11	0.15	2.49

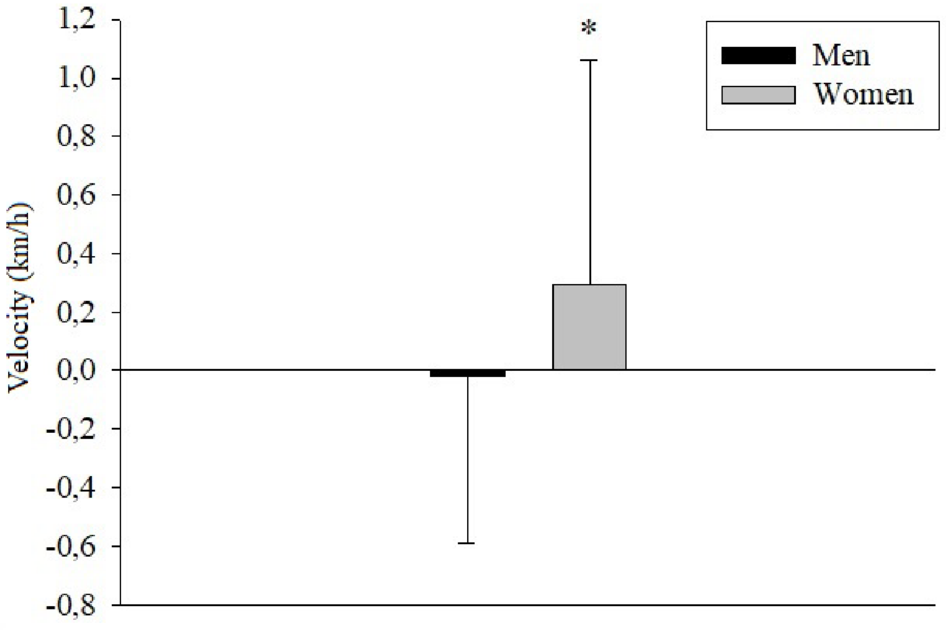

Figure 2 - General velocity variation from the male and female groups during the 10,000 race.
(*) different from the male group.

Discussion

The current study aimed to compare the 10,000 m race strategy between men and women. Men tend to reduce while women tend to increase the velocity at the first kilometer of the race and both groups increase the velocity at the end of the race. The strategy types proposed by Abbiss and Laursen[3] are based mainly on the curve shape composed by running pacing or velocity at each kilometer, and not based on statistical differences among kilometers. Therefore, the current results suggest that men employed a "U" shape running strategy, while women adopted two rhythms during the race: 1) a positive pacing strategy at the start of the race, and 2) a "J" strategy format in the second half of the race[3].

To the best of these authors' knowledge, this is the first study to investigate the gender effect in the 10,000 m race strategy, which limits to compare the present results with other studies. March[7] compared running pace between genders during a marathon. It was observed that women maintained a constant pace in the last 10 km of the marathon, while it was slightly reduced in men. According to the authors, women had better control over the race strategy when compared to men. The current results also suggest a difference in the long-distance race strategy between men and women. Another study evaluated running strategies used during men's world-record performances for 5,000 m and 10,000 m races[4]. A higher velocity was observed in the initial and final kilometers of the races. Therefore, it can be assumed that the race strategy in this previous study was similar to that found in the final half of the race in the male and female group only in the final half of the race.

It is known that there are psychological and physiological differences between genders, such as anxiety, aggression, and in the use of substrates and energy source[8,10,11]. Changes in psychological and physiological parameters seem to be linked to velocity oscillations throughout long-distance race[12]. It has been suggested that self-paced endurance exercise is regulated by sensory information related to physiological and psychological status[1,12]. For instance, muscle tension level, substrates availability, core temperature, motivation, and current perceived effort are continuously processed and integrated by the central nervous system, allowing to optimize race performance[15,16]. However, it is not possible to identify whether psychological and physiological parameters directly affected the race strategy in the current study.

Although the athletes experienced reductions in running velocity throughout the race, it appears that they were able to maintain a certain level of the physiological reserve to sustain or increase the pace at the end of race[5]. One of the main purposes of running strategy is to allow a better distribution of the energy expenditure associated with the best running pace and at the same time maintain an energetic reserve for the end of race[6]. Otherwise, fatigue would be installed, resulting in a velocity decrement in the final kilometers, and seriously damaging race performance[8].

Moreover, the present results suggested that men and women also differ in terms of running velocity variation. Both groups shifted running velocity throughout the 10,000 m race. However, women showed a greater overall variation when compared to men (Fig. 2). This finding also suggests that men and women control running pace differently throughout the 10,000 m race. According to March[11], differences in pace control between genders are related to the greater women's ability to use fats as an energy substrate, enhanced by their greater predominance of type I fibers[8,9]. In addition, the psychological factors mentioned above (e.g., motivation and perception, etc.) may also be involved in pace control differences between genders.

Finally, the present study has some limitations. The source of the data used is restricted. Although the sample is composed of world-class athletes, additional information such as body composition, sociodemographic profile or other characteristics that may be associated with the athletes' performance are not available. Adding, as it is a study with data already collected, the researchers had no control over the procedures and therefore it is not possible to present more information about them.

Conclusion

The results of the present study suggest that there are a sex differences in the 10,000m race strategy. Women word-class runners showed greater pacing variation in comparison to men. From a practical standpoint, coaches, exercise physiologists, and athletes must be aware of the differences in running strategy between men and women throughout the 10,000 m race. In addition, these differences between the sexes must be taken into consideration for the training process.

The perspectives and information presented in this study are not limited to high-performance sports. Like other studies in different areas, the present study showed some peculiarities between the sexes during the exercise performance. This information can also reflect on the process of training and teaching young athletes. Physical education professionals and other coaches should consider possible differences in behavior in a long-distance running race from their novices. Thus, the requirements and parameters of teaching and training should not necessarily be the same among athletes of different genders. Future research should investigate the effect of gender on running strategy by evaluating athletes of different levels (e.g., amateurs, at the national level, etc.) and races involving different distances covered (e.g., 3,000 m, 5,000 m).

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Acknowledgments

The authors express their gratitude to Fundação de Amparo à Pesquisa de Minas Gerais (FAPEMIG) and the Pró-Reitoria de Pesquisa e Extensão da UEMG.

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Manuscript received on October 21, 2020

Manuscript accepted on January 3, 2021