Pacing profiles of senior men and women at the 2017 IAAF World Cross Country Championships

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ABSTRACT

The purpose of this study was to analyse and compare pacing profiles of senior men and women competing in the 2017 World Cross Country Championships. Finishing and split times were collated for 118 men and 81 women competing over the newly introduced race distance of 10 km (five laps of approximately 2 km). Athletes were grouped according to finishing time, and changes in pace measured using lap times, except between Laps 1 and 2 because of a shorter first lap (times relative to the winner were used instead). Within both men's and women's races, groups slowed during the early stages, but then either sped up or maintained pace during the last lap. There were few differences between groups with regard to overall pacing profiles, or between sexes. The men's fast finish contrasted with slower finishes found in previous editions (over 12 km), and the degree to which women were slower than men (approximately 12%) was very similar to track racing and showed the decision to equalise the distances run by both sexes was sound. As in other distance events, athletes are recommended to try to achieve an even pace throughout, an approach that proved beneficial to both gold medallists.

INTRODUCTION

An athlete's running speed is very rarely constant throughout a race; instead, pacing profiles vary for many reasons, including fatigue, tactics and psychological factors. Pacing profiles have been categorised as positive (the athlete's speed decreases), negative (the athlete speeds up), even (a constant speed is maintained), variable (speed increases and decreases throughout), and parabolic-shaped (fast pace at the start and finish with a slower mid-section) (Abbiss & Laursen, 2008; de Koning et al., 2011). Many athletes adopt the simple and psychologically less-taxing principle of following the lead pace for as long as possible (Hanley, 2014), with most eventually dropping off the leaders to more comfortable and stable speeds (Thiel, Foster, Banzer, & de Koning, 2012), with a small number dropping out completely. Such tactics might be adopted because opponents present several affordances that affect motivation, positioning and drafting (Hettinga, Konings, & Pepping, 2017), and one benefit is the use of other athletes as external references for pacing (Renfree, Martin, Micklewright, & St Clair Gibson, 2014). Highly trained athletes regulate their rate of work output to optimise performance (Abbiss & Laursen, 2008), and evenly paced profiles are generally considered optimal for endurance running, especially when aiming to achieve a specific time. However, pace must be modulated slightly to account for environmental factors such as gradient (during non-stadia running events) or wind (Angus, 2014). In addition, the tactical nature of championship races, where finishing position is more important than finishing time (Thiel et al., 2012), often results in parabolic-shaped or variable pacing profiles instead (Thompson, 2007).

Competing over natural terrain in the form of cross country running, trail running, orienteering and fell running is popular with athletes of all abilities. Cross country running is an event quite separate from track or road running as it requires a different running technique, although how much it differs can depend on course conditions as variations in terrain can be considerable (Canova, 1998). Maintaining constant speed or energy consumption is difficult in cross country because International Association of Athletics Federations (IAAF) Rule 250.1(a) states that course design should incorporate natural obstacles to create a challenging course (IAAF, 2015); it is also difficult for athletes to achieve a specific pace as no distance markers are used, and laps can alter in length. Because of this, Hanley (2014) found that the predominant tactic in the senior men's World Cross Country Championships was for athletes to follow the lead group pace for as long as possible. As gold medallists were consistently within 2 s of the leader from the opening lap onwards, cross country is not an event where athletes make late surges to win, at least not at world-class standard (Hanley, 2014). Many distance runners, who slow having followed the lead pace at the beginning, increase pace again once they know they are near the end of the race (de Koning et al., 2011; Swart et al., 2009), although Hanley (2014) found that men running in the World Cross Country Championships did not increase their pace on any lap, including the final one. It is therefore possible that the all-out nature of cross country running leads to fatigue too great to allow for fast finishes.

The IAAF World Cross Country Championships were first held in 1973, when the distances covered by senior men and women were approximately 12 km and 5 km, respectively. Gradual modifications occurred over time, with the senior women's race held over 8 km from 1998 to 2015, but from 2017 onwards both senior men and women compete over 10 km (there is still a 2 km difference in distance for men and women competing in under-20 age-group races). Sex-based differences in pacing have been found in both world-class and non-elite standard marathon runners (Deaner, Carter, Joyner, & Hunter, 2015; Hanley, 2016), where it is possible that women's more even pacing is because of physiological differences such as their lesser likelihood of glycogen depletion (Tarnopolsky, 2008). However, Deaner & Lowen (2016) suggested that because high school girls paced themselves better than boys over the first two miles of a 5 km cross country race (where glycogen depletion is irrelevant) that psychological factors such as overconfidence and risk perception might be more important reasons for men's quicker, less cautious early paces. With regard to world-class competition, the 2017 edition of the World Cross Country Championships present the first opportunity to compare the pacing profiles and overall performances of men and women over the same distance and course. This research can show whether the pacing differences found previously are also found in a setting different from track or road running, and whether there is specific new advice that coaches can adopt. With regard to novel findings, women's pacing profiles at the World Cross Country Championships have not been studied before, and it will also be of interest to observe whether changes in men's pacing profiles have occurred with the decrease in distance. The aim of this study was to analyse and compare pacing profiles used by elite-standard senior men and women in the 2017 IAAF World Cross Country Championships.

METHODS

Participants

The study was approved by the School Research Ethics Committee. Overall race times and lap times were obtained from the open-access IAAF website (IAAF, 2017a, 2017b) for competitors in the senior men's and women's races at the IAAF World Cross Country Championships held in 2017 in Kampala, Uganda. A total of 199 finishers (118 men and 81 women) were analysed. The performances of seven men and four women who did not finish, and of 14 men and 15 women considered very slow (i.e., with a finishing time more than 25% greater than the winner's time), were excluded. Of the remaining athletes, the total complement of lap times was not available for four men and four women and none of these competitors' data have been included.

Data Analysis

The study was designed as observational research in describing pacing profiles. Competitors in each race were first divided into four groups based on finishing times, similar to previous research (Hanley, 2015), and each athlete was placed in one group only. These groups were athletes whose finishing times were within 5% of the winner's time in their respective races (the 5% group: 23 men; 14 women); athletes whose finishing times were between 6% and 10% slower than the winner's time (the 6–10% group: 35 men; 14 women); athletes whose finishing times were between 11% and 15% slower than the winner's time (the 11–15% group: 32 men; 26 women); and athletes whose finishing times were between 16% and 25% slower than the winner's time (the 16–25% group: 28 men; 27 women). All finishing time percentages were rounded to the nearest integer before athletes were allocated to a group. Comparisons between laps (and groups) were conducted using absolute lap time, except between Laps 1 and 2 because the first lap was shorter than the four following laps (which were the same length, although the actual distance per lap was described only as “a loop of approximately 2000m”) (IAAF, 2017c). Because of this, lap times were also calculated as a percentage of the eventual winner’s time for that lap (which was expressed as 100%) to measure relative changes in pace between the first and second laps (and overall differences between men and women). The laps also differed in that three 0.4 m obstacles (logs) were added to all laps except the first (IAAF, 2017c).

Statistical analysis

The lap time percentages were arcsine transformed for the purposes of statistical analysis (Hanley, 2015). One-way repeated measures analysis of variance (ANOVA) was conducted on the lap times and percentages, with repeated contrast tests conducted to identify changes between successive laps (Field, 2009). Greenhouse-Geisser corrections were used if Mauchly’s test for sphericity was violated. In addition, one-way ANOVA with Tukey’s post-hoc tests was conducted to compare mean lap times between groups (Field, 2009). Lap time percentages and absolute finishing times for men and women were compared using independent *t*-tests. Statistical significance was accepted as $P < .05$. Effect sizes (ES) for differences between successive laps, and between groups and sexes on each lap, were calculated using Cohen’s *d* (Cohen, 1988) and considered to be either trivial (ES < 0.20), small (0.21 – 0.60), moderate (0.61 – 1.20), large (1.21 – 2.00), very large (2.01 – 4.00), or nearly perfect (> 4.00) (Hopkins, Marshall, Batterham, & Hanin, 2009).

RESULTS

Figure 1 shows the mean lap time for each group of men at the end of each lap, and Figure 2 shows the mean lap time for each group of women; the lap times for the winner of each race are also shown. Differences between successive splits have been annotated in Figures 1 and 2 only when the ES was moderate or larger; differences between Lap 1 and 2 were annotated based on lap time percentages as described above. In the men's race, the 5% group were faster than the other groups by the end of Lap 1, and after each subsequent lap ($P < 0.001$); ES values ranged between 1.15 and 6.14. The 6–10% group were faster than the 11–15% and 16–25% groups after each lap ($P \leq 0.003$, ES between 0.72 and 4.01), and the 11–15% group were faster than the 16–25% group after each lap ($P \leq 0.026$, ES between 0.81 and 2.52). In the women's race, the 5% group were also faster than all three other groups by the end of Lap 1, and after each subsequent lap ($P < 0.001$); ES values ranged between 1.06 and 5.52. As with the men, the 6–10% group were faster than the 11–15% and 16–25% groups after each lap ($P \leq 0.024$, ES between 1.09 and 3.04), and the 11–15% group were faster than the 16–25% group after each lap ($P \leq 0.002$, ES between 0.91 and 1.81).

**** Figure 1 near here ****

**** Figure 2 near here ****

The winning time in the men's race was 28:24 (lap splits of 5:12, 5:50, 5:46, 5:45 and 5:51), with a winning margin of 12 s, whereas in the women's race the winning time was 31:57 (lap splits of 5:59, 6:26, 6:28, 6:34 and 6:30), with a winning margin of 4 s. The winner of the men's race was 12 s behind the leader at the end of Lap 4, but the winner of the women's race never had a split time more than 1 s behind the leader; both gold medallists took the lead for the first time during the last lap. With regard to all athletes who were included for analysis, the women's mean time of 35:53 (± 1:52) was 12.3% slower than the men's mean time (31:28 ± 1:42) (P < 0.001, ES = 2.49). Figure 3 shows the mean lap time percentages for all men and all women analysed. The men had faster lap time percentages than the women after Lap 2 (P < 0.001), Lap 3 (P = 0.049) and Lap 5 (P = 0.003); however, the associated ES values were all small (0.54, 0.29 and 0.43, respectively).

**** Figure 3 near here ****

DISCUSSION

The aim of this study was to analyse and compare the pacing profiles used by senior men and women competing in the 2017 IAAF World Cross Country Championships. In the men's race, all groups started off quickly (mean lap times within 10% of the winner's pace), although the 5% group were nonetheless still faster than the other groups by this time. This fast start resulted in progressively slower laps in most instances (exceptions being the 5% group after Lap 2, and the 6–10% group after Lap 4). Despite this, the 11–15% and 16–25% groups ran quicker in the last lap compared with the penultimate lap, and the 5% and 6–10% groups maintained their pace. The men's overall pacing profiles therefore resembled reverse J-shaped pacing (a form of parabolic-shaped pacing) (Abbiss & Laursen, 2008), which contrasts with the profiles found in previous World Cross Country Championships, where no groups of men (similar in standard to those in this study) sped up on the final lap

(Hanley, 2014). One possible reason for this difference in pacing profiles was the shorter distance over which senior men now compete (10 km rather than 12 km) that resulted in less fatigue and hence preserved metabolic reserves that could be used for a fast finish (Burnley & Jones, 2010). It is not unusual for athletes to speed up in the final stages of a race, even if they have been progressively slowing, as there is a psychological boost in knowing the finish is near (de Koning et al., 2011; Swart et al., 2009), and this was also possibly a factor. Coaches of senior men cross country runners should reflect on this change in pacing profiles with regard to the greater importance of the endspurt when considering race-specific training.

In the women's race, all groups had a fast opening lap and slowed during the following two laps, with the 6-10% and 16-25% groups slowing further during Lap 4. Despite this, all groups then either sped up or maintained their mean pace until the end of the race, similar to how the men paced themselves. This finding contrasted with previous similar research on distance running that showed that women achieved more even pacing than men (e.g., Deaner, Addona, Carter, Joyner, & Hunter, 2016; Hanley, 2016), and thus there was no strong evidence of physiological or psychological differences in pacing behaviour amongst these elite-standard runners. This was the first occasion that women competed over the longer distance of 10 km, but as athletes who participate in this competition are typically world-class over distances up to the marathon (Tulloh, 1996), the increase in distance was possibly not a factor in how women paced themselves. Because there have been no previous studies of senior women's pacing profiles at the World Cross Country Championships, the impact of the increase in distance cannot be compared with those races formerly held over 8 km. Instead, it is possible that future editions of the

World Cross Country Championships will show how typical (or atypical) these pacing profiles are for cross country running, especially given the relatively flat (Henderson, 2017; IAAF, 2017c) and hot conditions (temperature of 26°C (IAAF, 2017a; 2017b)) experienced in Kampala.

On average, the women were approximately 12% slower to complete the 10 km distance than the men. This finding was very similar to sex-based time differences over this distance on the track (Cheuvront, Carter, DeRuisseau, & Moffatt, 2005), and is attributed to men's greater maximal oxygen uptake (Deaner & Lowen, 2016). There is therefore no greater difference between sexes when competing in cross country, and the recent equalisation of distances for men and women is therefore sound. Only small differences were found between men's and women's relative times after Laps 2, 3 and 5 (with none after Laps 1 and 4), showing that both groups paced themselves in a similar fashion overall (i.e., starting too quickly). This contrasts with World Championship marathon running, where women were found to undertake more even paced running than men (Hanley, 2016), and might have been because cross country racing does not provide external cues to assist pacing. It should be noted that even though the groups of men and women either maintained their pace or sped up during the last lap, their overall pacing profiles were positive because of their considerable slowing down beforehand. Running well at the end of the race is of course beneficial to overall performance, but it can disguise poor decision-making earlier in the race; a more conservative opening pace that can be maintained throughout tends to lead to better performances (Abbiss & Laursen, 2008) and should be encouraged. As with other analyses of distance running (e.g., Hanley, 2014), this study has analysed macrovariations in pacing, as split times were available only after each lap of approximately 2 km. Small variations in pace during these particular races, such as those during tactical bursts of speed or caused by the obstacles and ditches included (Henderson, 2017), cannot be measured but might be decisive in competitive terms. Such variations in pace have indeed been found in mountain biking that also includes topographical and technical variations during each lap (Martin, Lambeth-Mansell, Beretta-Azevedo, Holmes, Wright, & St Clair Gibson, 2012) and could be important with regard to overall pacing behaviour. Cross country coaches are therefore recommended to incorporate similar intermittent bursts into training sessions where the aim is still to maintain an overall even pace.

The gold medallists ran even splits for Laps 2 to 5 (i.e., those laps that were the same length), with only 6 s difference between the winning man's fastest and slowest laps, and 8 s difference between the winning woman's fastest and slowest laps. Their pacing profiles reinforce the recommendation for athletes to adopt even-paced running, especially as the winner of the men's race managed to overcome a 12 s deficit during the last lap. However, this might have been as much caused by poor pacing on the part of the athlete leading at the start of the last lap, who eventually finished more than 100 s behind the winner. This particular athlete's poor pacing might have been a result of the over-excitement of leading in front of his home crowd, many of whom ran alongside him during the last lap (Henderson, 2017). Overcoming such a large gap is unusual in cross country, where most gold medallists are within only a few seconds of the leader throughout (Hanley, 2014), and many cross country runners follow the lead group for as long as possible because of its affordances (including using other athletes as pacemakers, as variable course conditions and no distance markers cause time to be an unreliable external reference). However, athletes can learn to ignore such affordances because of their potentially negative effects on pacing (Hettinga et al., 2017), and indeed the men's gold medallist stated that he ran his own race as he knew the early leader's pace "was too high" (Henderson, 2017, p. 9). It can be difficult for athletes to ignore the fast start made by rivals, especially considering how greater motivation might lead to an underestimation of one's rating of perceived exertion (Hall, Ekkekakis, & Petruzzello, 2005), but it is nevertheless an important skill to learn (Hettinga et al., 2017), and should be an integral part of an endurance athlete's training regimen.

Because the first lap was shorter than the others and with no obstacles, it was not possible to analyse the difference between Laps 1 and 2 with absolute values, and thus reference values (the eventual men's and women's winners' lap times) were used. Although this is a limitation of the study, the winners' times were chosen as cross country is a competition where times in themselves are largely meaningless except in the context of the race, and were important with regard to establishing to some extent the relative effect of the early pace adopted by each group of athletes. The lack of precisely measured lap distances limited the analysis to comparisons between athletes and sexes within this championship, and meant that it was not possible to accurately calculate variables (e.g., lap speed) that could be used for comparisons with other studies on endurance events. As a result, future studies of cross country running that can avail of timed, equal-length laps with measurements of within-lap variations will greatly benefit coaches of cross country athletes with regard to pacing advice, and allow for comparisons with other events that could put cross country pacing into a wider context.

CONCLUSIONS

This study analysed senior men's and women's pacing profiles at the 2017 World Cross Country Championships. Both sexes began quickly and displayed positive pacing profiles overall; however, the groups within both men's and women's races either sped up or managed even-paced running during the last lap. The shorter, 10 km distance that senior men now run might have been partly responsible for their faster finish compared with previous editions of the race. There were only small differences between sexes for pacing as women started just as quickly as men, and thus all cross country athletes should undertake training that emphasises a conservative (but still competitive) opening pace that allows for even pacing. The gold medallists demonstrated the benefits of even-paced running, to the extent that in the men's race the deliberate avoidance of following a poorly-pacing leader allowed for a 12 s deficit with one lap remaining to be turned into a 12 s victory.

DISCLOSURE STATEMENT

The author reports no conflicts of interest.

REFERENCES

Abbiss, C. R., & Laursen, P. B. (2008). Describing and understanding pacing strategies during athletic competition. *Sports Medicine*, *38*, 239-252. doi: 10.2165/00007256-200838030-00004

Angus, S. D. (2014). Did recent world record marathon runners employ optimal pacing strategies? *Journal of Sports Sciences*, *32*, 31-45. doi: 10.1080/02640414.2013.803592

Burnley, M., & Jones, A. M. (2010). 'Traditional' perspectives can explain the sprint finish. In: Comments on Point:Counterpoint: Afferent feedback from fatigued locomotor muscles is/is not an important determinant of endurance exercise performance. *Journal of Applied Physiology*, *108*, 458-468. doi: 10.1152/japplphysiol.01388.2009

Canova, R. (1998). Can cross-country running be considered an athletics event in its own right? *New Studies in Athletics*, *13*(4), 13-19. Retrieved from https://www.iaaf.org/nsa/article/filter?&authorId=5461fcc41111ff42acac6b6e

Cheuvront, S. N., Carter, R., DeRuisseau, K. C., & Moffatt, R. J. (2005). Running performance differences between men and women: An update. *Sports Medicine*, *35*, 1017–1024. doi: 10.2165/00007256-200535120-00002

Cohen, J. (1988). *Statistical power analysis for the behavioural sciences (2nd ed.)*. Hillsdale, NJ: Lawrence Erlbaum.

Deaner, R. O., Addona, V., Carter, R. E., Joyner, M. J., & Hunter, S. K. (2016). Fast men slow more than fast women in a 10 kilometer road race. *PeerJ*, *4*, e2235. doi: 10.7717/peerj.2235

Deaner, R. O., Carter, R. E., Joyner, M. J., & Hunter, S. K. (2015). Men are more likely than women to slow in the marathon. *Medicine and Science in Sports and Exercise*, *47*, 607-616. doi: 10.1249/MSS.0000000000000432

Deaner, R. O., & Lowen, A. (2016). Males and females pace differently in high school cross-country races. *Journal of Strength and Conditioning Research*, *30*, 2991-2997. doi: 10.1519/JSC.0000000000001407

de Koning, J. J., Foster, C., Bakkum, A., Kloppenburg, S., Thiel, C., Joseph, T., Cohen, J., & Porcari, J. P. (2011). Regulation of pacing strategy during athletic competition. *PLoS ONE*, *6*(1), e15863. doi: 10.1371/journal.pone.0015863

Field, A. P. (2009). *Discovering statistics using SPSS (3rd ed.)*. London: Sage.

Hall, E. E., Ekkekakis, P., & Petruzzello, S. J. (2005). Is the relationship of RPE to psychological factors intensity-dependent? *Medicine and Science in Sports and Exercise*, *37*, 1365-1373. doi: 10.1249/01.mss.0000174897.25739.3c

Hanley, B. (2014). Senior men’s pacing profiles at the IAAF World Cross Country Championships. *Journal of Sports Sciences*, *32*, 1060-1065. doi: 10.1080/02640414.2013.878807

Hanley, B. (2015). Pacing profiles and pack running at the IAAF World Half Marathon Championships. *Journal of Sports Sciences*, *33*, 1189-1195. doi: 10.1080/02640414.2014.988742

Hanley, B. (2016). Pacing, packing and sex-based differences in Olympic and IAAF World Championship marathons. *Journal of Sports Sciences*, *34*, 1675-1681. doi: 10.1080/02640414.2015.1132841

Henderson, J. (2017, March 30). Kamworor breaks Ugandan hearts. *Athletics Weekly*, pp. 8-9.

Hettinga, F. J., Konings, M. J., & Pepping, G.-J. (2017). The science of racing against opponents: Affordance competition and the regulation of exercise intensity in head-to-head competition. *Frontiers in Physiology*, *8*, 118. doi: 10.3389/fphys.2017.00118

Hopkins, W. G., Marshall, S. W., Batterham, A. M., & Hanin, J. (2009). Progressive statistics for studies in sports medicine and exercise science. *Medicine and Science in Sports and Exercise*, *41*, 3-12. doi: 10.1249/MSS.0b013e31818cb278

IAAF (2015). Competition rules 2016-17. Monte Carlo: IAAF.

IAAF (2017a). Senior race women. Retrieved from https://www.iaaf.org/competitions/iaaf-world-cross-country-championships/iaaf-world-cross-country-championships-kampal-5837/results/women/senior-race/final/result#resultheader

IAAF (2017b). Senior race men. Retrieved from https://www.iaaf.org/competitions/iaaf-world-cross-country-championships/iaaf-world-cross-country-championships-kampal-5837/results/men/senior-race/final/result#resultheader

IAAF (2017c). IAAF World Cross Country Championships Kampala 2017 – Team manual. Retrieved from https://media.aws.iaaf.org/competitioninfo/3760d72e-fdf9-45ee-a016-2f2da87e3b49.pdf

Martin, L., Lambeth-Mansell, A., Beretta-Azevedo, L., Holmes, L. A., Wright, R., & St Clair Gibson, A. (2012). Even between-lap pacing despite high within-lap variation during mountain biking. *International Journal of Sports Physiology and Performance*, *7*, 261-270. doi: 10.1123/ijspp.7.3.261

Renfree, A., Martin, L., Micklewright, D., & St Clair Gibson, A. (2014). Application of decision-making theory to the regulation of muscular work rate during self-paced competitive endurance activity. *Sports Medicine*, *44*, 147-158. doi: 10.1007/s40279-013-0107-0

Swart, J., Lamberts, R. P., Lambert, M. I., Lambert, E. V., Woolrich, R. W., Johnston, S., & Noakes, T. D. (2009). Exercising with reserve: exercise regulation by perceived exertion in relation to duration of exercise and knowledge of endpoint. *British Journal of Sports Medicine, 43*, 775–781. doi: 10.1136/bjsm.2008.056036

Tarnopolsky, M. A. (2008). Sex differences in exercise metabolism and the role of 17-beta estradiol. *Medicine and Science in Sports and Exercise, 40,* 648-654. doi: 10.1249/MSS.0b013e31816212ff

Thiel, C., Foster, C., Banzer, W., & de Koning, J. (2012). Pacing in Olympic track races: competitive tactics versus best performance strategy. *Journal of Sports Sciences, 30,* 1107-1115. doi: 10.1080/02640414.2012.701759

Thompson, P. J. L. (2007). Perspectives on coaching pace skill in distance running: a commentary. *International Journal of Sports Science and Coaching, 2,* 219-221. doi: 10.1260/174795407782233128

Tulloh, B. (1996). *Running is easy*. London: CollinsWillow.

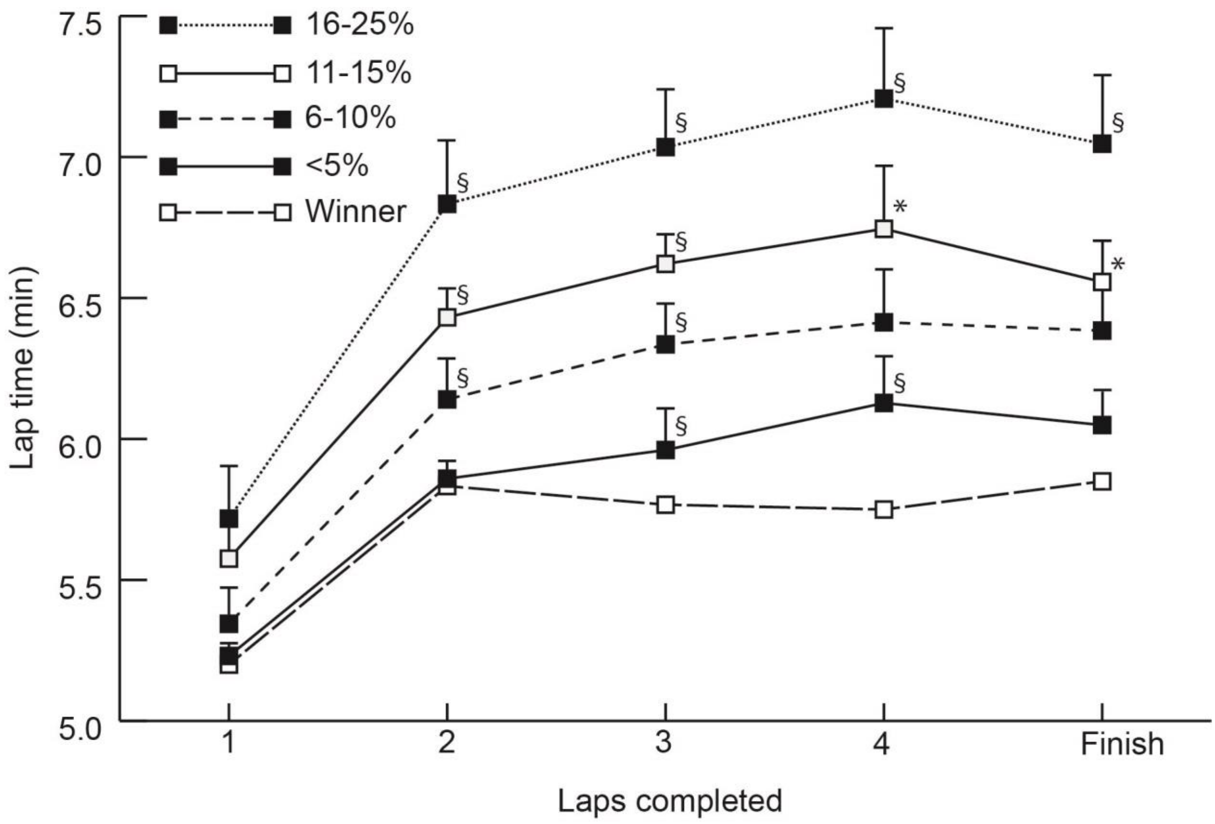

Figure 1. Mean (+ SD) lap time for each group of men after each lap. The lap times for the winning athlete are also shown. Differences between successive laps are shown as either $P < .01$ (*) or $P < .001$ (§). Because the first lap was shorter than the others, comparisons between Laps 1 and 2 were made using lap time percentages based on the winner's time for those laps.

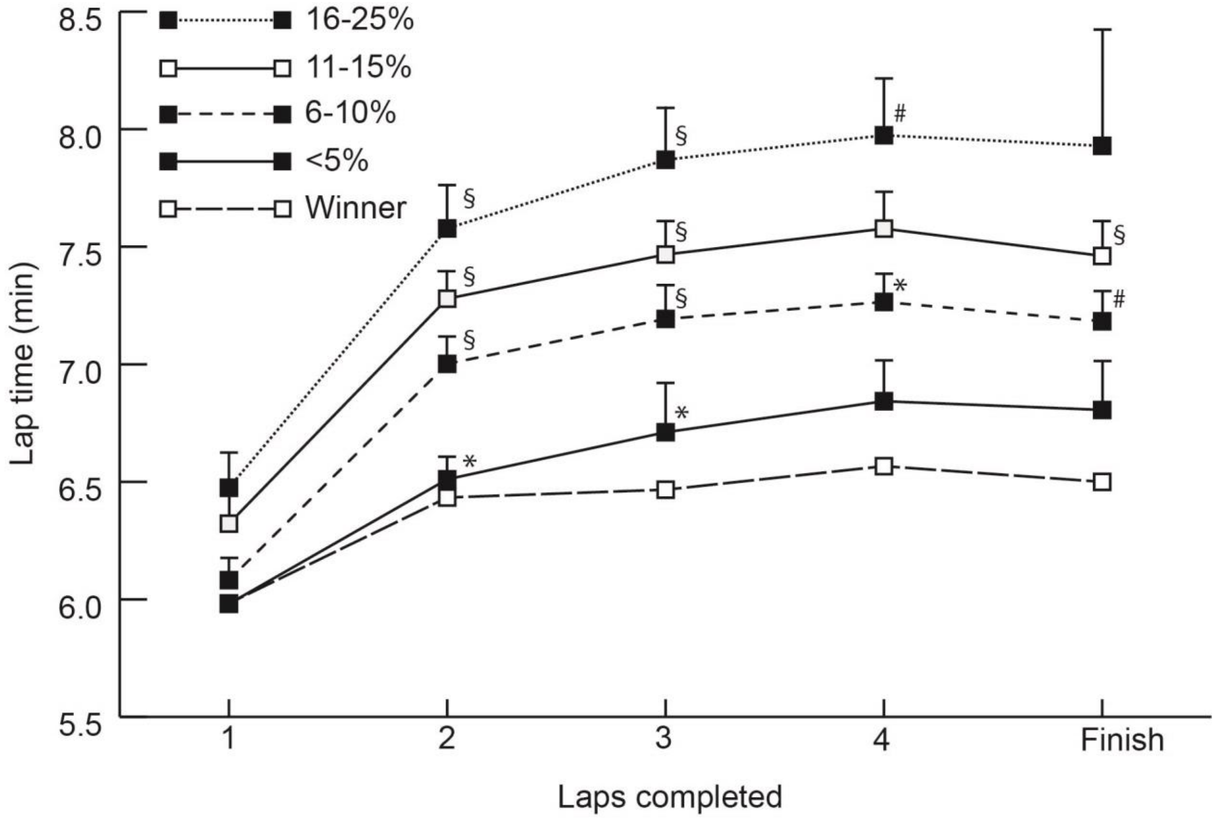

Figure 2. Mean (+ SD) lap time for each group of women after each lap. The lap times for the winning athlete are also shown. Differences between successive laps are shown as either *P* < .05 (#), *P* < .01 (*) or *P* < .001 (§). Because the first lap was shorter than the others, comparisons between Laps 1 and 2 were made using lap time percentages based on the winner's time for those laps.

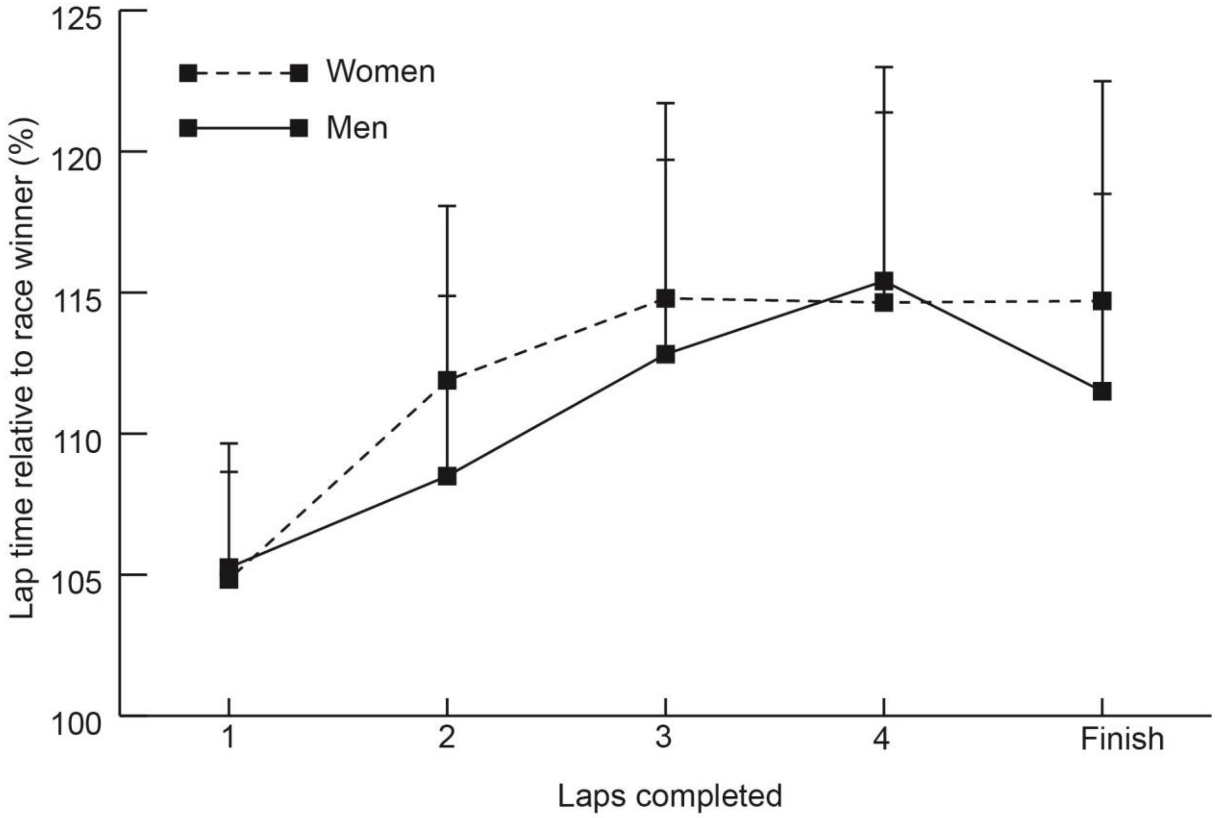

Figure 3. Mean (+ SD) lap time relative to the race winner's pace for all men and women after each lap.