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PERFORMANCE TRENDS IN LARGE 10-KM ROAD RUNNING RACES IN THE UNITED STATES

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Abstract

Our study examines the current trends of runners participating in 10-km road races in the United States. Finish times and ages of all runners participating in 10 of the largest 10-km running races in the United States between 2002–2005 and 2011 were recorded. Linear regression analysis was performed to examine the trends for age, sex, and finishing time for all participants completing the course in <1 hour. A total of 408,296 runners were analyzed. There was a significant annual decrease in the ratio of men to women finishers ($p < 0.001$, $r^2 = 0.976$). The average finishing time of the top 10 (men, $p \leq 0.05$), 100 (men and women, $p \leq 0.05$), and 1,000 (men and women, $p < 0.01$) significantly decreased annually. The total number of subhour finishers increased annually across all races (194 men per year, $r^2 = 0.584$, $p = 0.045$; 161 women per year, $r^2 = 0.779$, $p = 0.008$), whereas the percentage of overall finishers completing the course in less than an hour significantly declined for men and women ($p \leq 0.003$). There was a significant trend toward younger men in all top groups except for the single fastest runner ($p \leq 0.017$). Our study demonstrates that for large 10-km U.S. races: the top men and women seem to be getting faster; there are more subhour finishers, with increasingly more women accomplishing this feat compared with men; an increasingly lower percentage of overall finishers is finishing in <1 hour; and the fastest men are also increasingly younger.

Keywords

age; sex; speed; epidemiology

Introduction

Ten kilometer races are consistently found to be among the most popular running distances, even greater than marathons. Two of the 3 largest road races in the United States (29) are 10-km races; this distance is also a popular Olympic track and field sport. The distance will likely gain in popularity after Galen Rupp of the United States earned a silver medal in arguably the most exciting running race in the 2012 Olympic games in London—the first

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American medal in 48 years (26). There were approximately 1.3 million finishers in 10-km road races in the United States in 2010 (compared with only 507,000 marathon finishers) with median finishing times of 55:56 (minutes:seconds) and 1:04:41 (hours:minutes:seconds) and mean ages of 38.1 and 35.3 years for men and women, respectively (28). However, surprisingly, little data appear in the literature about the evolution of 10-km races over time like there has been with other distances, particularly marathons (1,6,12–15,18,20,27,31,35,36), ultramarathons (12–14,31), and triathlons (22,23,30,34). In general, the "middle-distance" runs (5– and 10-km races) have a scarcity of data despite accounting for the vast majority of participation in American recreational runners. To the authors' knowledge, nothing has been recently published about the demographics and trends in participation for 10-km races.

In marathons, there have been several studies examining the age and finish times of the participants (9,15,19,20,24,27,36); although data are conflicting, trends tend to show that the speed of the elite marathoners (men and women) is slightly increasing over time. For ultramarathons, there seems to have been a plateau for the finish times (13). For shorter endurance events like the 1,500 m, there also appears to be a continuing increase in speed among men greater than among women (25). At the 10-km distance, the world record finish times for men have also been steadily decreasing, although the record for a North American runner (Mark Nenow, 1984) has stood for decades (10). For women, the world record has remained for almost a decade (Paula Radcliffe, 2003) (10,32) and the North American was set in 1996 (Angela Chalmers). At the world-record level, the greatest difference in speed between sexes has been the 5- to 10-km range (5). The fastest runners at the 10-km distance tend to have a set of distinct anthropometric characteristics, including being shorter and lighter, with smaller skinfold values, and more ectomorphic than average runners (2).

To the authors' knowledge, there has not been any recent data published about the trends for elite or recreational runners in the 10-km races. The races vary in size from a few participants up to 50,000 in the United States; the largest races have a predefined maximum number of runners and can sell out in days. These large races also attract international professional runners for the prize money associated. A popular finishing time goal, and the focus of many training programs, is to complete the course in <1 hour. For runners in older age groups, this is also seen as a competitive finishing time. Several races, until recent years (because of advances in timing technology), would cease timing participants after an hour. As a frame of reference, the world records at this distance are 26:44 for men and 30:21 for women (10). Because of the large size of these races, many of the runners, particularly those who complete the course in longer times, are unable to run personal bests owing to the crowded race conditions. We examined all runners who completed the race in <1 hour and looked for trends among the top 1st-, 10th-, 100th-, and 1,000thplaced runners.

In this study, 10 of the largest 10-km running competitions held in the United States were analyzed to identify the performance and demographic trends for this distance. We believe that it is important to better understand these trends because of the sheer size of this enlarging demographic, which remains unstudied. Improved knowledge of this sizeable population will allow for better treatment by medical practitioners for their runningrelated injuries and will open the door for further research into the middle distance– related injuries

they sustain. Some evidence exists for an increase in injuries for greater training distances, competitive runners, and participation in races of a greater distance (37). There are limited data available specifically for 10-km running injuries (17), which do not completely match the injuries found in longer distances.

Specifically for this study, we were interested in following trends over time within each race and across all races. We sought to determine (a) if 10-km runners were getting faster for each sex, (b) if 10-km runners were getting younger for each sex, and (c) if the ratio of men to women was changing.

Methods

Experimental Approach to the Problem

The objective of this investigation was to determine the trends for age, sex, and finishing times in large 10-km running competitions in the United States. Results for 10 of the largest 10-km running competitions held in the United States (29) were obtained (Table 1) using publicly available results.

Subjects

Runners involved in the aforementioned races were included in the study; wheelchair racers were not included. Runners who did not complete the race were not recorded. This study was approved by our Institutional Review Board as an “exempt” study because it used publicly available data for analysis. Consent was not deemed necessary by the review board as this was a compilation of publicly-available data without personally-identifiable information.

Procedures

All data were obtained from publicly available sources for 10 of the largest 10-km running competitions held in the United States, including individual race websites and direct communication with race directors for clarification. The total number of participants in each race was recorded, with all participants who completed the course in <1 hour included in the analysis. Data included the following 3 items: age, sex, and finish time (when available, an electronically recorded chip time was used over gun to finish line time). Years that had incomplete data were not included in the analysis. If a participant’s age was not available, seemingly incorrect (e.g., 1 year old), or older than 95 years (as often times “99” is inserted if an age is unknown), their age was excluded from the analysis. If the sex or finish time was not available or seemingly incorrect (e.g., 0 hours, 00 minutes, and 40.5 seconds), the participant was not included in the study. It should be noted that several finishers ran the same race in different years, so technically, finishes were recorded, although we identify them in this article as “finishers.”

Statistical Analyses

We conducted an “across-race” analysis that includes all aggregate data of all runners across all the races. We also conducted a “within-race” analysis of runner data that examined specific trends of each particular race over time. The top 1, 10, 100, and 1,000 finishers of

each sex (divisions) were analyzed for each race. For across-race analysis, all data between the years 2005 and 2011 were included. For within-race analysis, some races had data available from before 2005 (as early as 2002), which was also included. The Wharf-to-Wharf 10-km race was included in the analysis for the top 1, 10, and 100 participants of each sex only, as this was all that could be obtained; it was not included in any of other within-race data or the across-race data. Data from all years of the AJC Peachtree Road Race were used in the top 1, 10, 100, and 1,000 calculations but were not used in the other within-race and across-race analyses. This is because the race had a change in their timing system in 2010; before that year, they only timed racers who were predicted to run under 1 hour, after which they timed all participants. Statistical analyses were performed using SPSS statistical software (version 18.0, SPSS Inc., Chicago, IL, USA). The within-race relationship between ages and finish times over time (years) was assessed by random-effect analysis of covariance. For across-race analysis, linear regression was performed on annual division means over the years studied. Differences at the $p \leq 0.05$ level were considered statistically significant.

Results

The total number of finishers for all races over the years studied, regardless of finish time, was 1,182,555, of which 553,522 (46.8%) were men, 585,463 (49.5%) were women, and 43,570 (3.7%) did not have their sex identified (Figure 1). The median race size was 7,795 finishers, ranging from 2,371 to 49,211. A total of 408,296 runners fit our inclusion criteria. For all finishers who completed the course under 1 hour, the median age was 34 years (36 ± 12.4 for men and 31 ± 10.2 for women), and the median finishing time was 52:43 (51:28 ± 6:05 for men and 54:39 ± 4:48 for women). The fastest winning times over all races were 27:35 (median 29:37) for men and 32:05 (median 34:27) for women.

Speed

Table 3 displays the statistical analysis of within-race speed trends seen over each year with the assumption that every year the racers will get faster. The winning times of the fastest racers within-races have remained stable over time; however, there are statistically significant improving trends in the fastest times for the 10th-, 100th-, and 1,000th-place finishers, for both men and women. Figure 2 represents only the finishing times of the 1,000th-place finishers over time as a representation of these trends. The top 10th- and 100th-place finisher analyses demonstrate similar trends. The finish time for the 100th- and 1,000th-place finishers significantly decreased from year to year, as well as the range between the 1st- and 1,000th-place finishers for both the sexes. Over the years studied for all races, the 1,000th place finishing time decreased by 0.428 minutes (26 seconds) per year for men and 0.173 minutes (10 seconds) per year for women. Figure 3 displays a histogram of all subhour participants over all races studied.

The number of runners who completed the race courses in under an hour increased annually for both men and women when controlled for race ($p < 0.001$) and when taken in aggregate (194 men per year, $r^2 = 0.584$, $p = 0.045$; 161 women per year, $r^2 = 0.779$, $p = 0.008$) (Figure 4). This also held true for the total number of finishers completing the course at any

finish time (3,335 men per year, $r^2 = 0.953$, $p = 0.001$; 6,226 women per year, $r^2 = 0.984$, $p < 0.001$). The absolute number of finishers completing the race in <1 hour has significantly increased over time, yet the percentage of overall finishers who completed the course in <1 hour significantly declined for both men and women—within-race analysis was significant for both the sexes ($p < 0.001$), and across-race analysis showed a decrease of 0.85% per year ($r^2 = 0.844$, $p = 0.003$) in men and 1.11% per year ($r^2 = 0.914$, $p = 0.001$) in women.

Age

The mean age of the top 1,000 finishers over all years and races was 34.3 ± 2.1 years for men and 31.9 ± 1.5 for women (Table 2). Table 4 displays the within-race and across-race age trends seen over each year. It shows no significant change in women's ages over the years studied. However, for men, there is a significant trend toward younger runners in all top groups except for the single fastest runner. Figure 5 shows the data in graphical format.

Sex

Of all the 408,296 runners who completed the races in <1 hour, 65.3% were men (266,682 runners) and 34.7% were women (139,416 runners). There was a significant decrease in the ratio of men to women finishers in the races over time ($p < 0.001$ controlled for race and in aggregate; $r^2 = 0.976$, $p < 0.001$) (Figure 6). Among the average times of the top 10 and top 100 finishers, and among the times of the 100th-place finisher, the slope was more negative for women than men (Table 3); this did not hold true by the 1,000th place finisher.

Discussion

Our study provides useful data for evidence-based practitioners in 2 realms. First, for strength and conditioning coaches working with runners, our results provide a framework of the demographics of middle-distance runners with whom they work; very little has been published on speed and age characteristics at this extremely popular distance. Moreover, we have demonstrated a large increase in women runners (who are now, in fact, the majority), which may serve to change the focus of training programs to emphasize sex-specific regimens. Second, our data can aid sports medicine practitioners. Some existing data suggest that faster finishing times, greater training distance per week, and entering multiple races increase injury in 10-km participants (37). Better understanding the demographics of 10-km participants may improve treatment and allow for more in-depth research of the middle-distance runner. Because so little has been published for middle-distance runners, we hope that our research demonstrates the importance of the need for more research on the injury mechanisms and treatment options specific to this large population.

This study demonstrates that both men and women in large 10-km U.S. road races had increasingly faster times among the top finishers. The top times were increasingly faster for men over time. Furthermore, the range between the 1,000th- and 1st-place finishers decreased for both men and women, which suggest that the competition in the front of these races is increasing. It should be noted that the fastest times, which were almost exclusively run by professional international runners, did not significantly improve over time. The most rapidly improving finish times are found in the top 1,000 men, as evidenced by the slope of

−0.428 minute per year (−25.7 second per year) for the 1,000th place finisher. This will surely plateau at some point, and the last few years have suggested a decrease in this trend. The top women also appear to be improving, just at a slower rate. This increase in speed could be well explained by improved training quality with the advancement and increasing accessibility of the young field of exercise science, or to external factors such as the recent popularization of midfoot running, which has been correlated with faster finishing times (11). We found high values of r^2 in our across-race analyses for several outcomes. Although these were significant trends, these values may also be a by-product of performing linear regression on a relatively short-time period (7 years) of division means.

There was also an increase in the number of finishers who completed the course in under 1 hour, but this growth was not proportional to the growth in overall finishers. This disproportionate increase was shown to be statistically significant when examining all finishers across all races and when comparing individual race growth trajectories. This lower percentage of subhour finishers implies that the majority of new finishers are running the race at a slower pace. This is likely because of 2 factors: First, an increase in the popularity of 10-km races attracts more novice runners, who tend to have slower finishing times. Second, the races studied were large races held on relatively small scales; so much so, in fact, that often times the first finishers have completed the race before many runners have even started the race. This likely had the effect of slowing runners' times (although unlikely affecting the fastest runners), and as the races studied were becoming larger, this bottleneck effect may have also increased over the years. To the authors' knowledge, the effect of race size on an individual's finishing time has not been studied for any distance.

The ages of the peak performers for men and women have been reported to be similar at the marathon distance (16), and the fastest times appear to decrease with each decade of life after 30 years of age (36). For the 10-km distance, the ages of the runners who set world records were 22 years for Leonard Patrick Komon (26:44 in 2010) and 29 years old for Paula Radcliffe (30:21 in 2003) (10). Over the years included in this study, the ages of the cohorts of women (e.g., top 10 finishers, top 100 finishers, etc.) did not significantly increase or decrease. This suggests that the faster women are either (a) becoming slower (and thus dropping out of the "fast" groups that were being studied) and being replaced by women of a slightly younger age or (b) the runners in the fast groups are maintaining their speed (while aging yearly), and an influx of slower younger runners is offsetting this natural increase in age. Men, however, are showing trends toward having increasingly younger runners in the top groups. This did not prove to be significant for the individual winners of the races but was significant for the top 10, 100, and 1,000 runners, as well as all men completing the course in <1 hour. If the same men were to stay in the race year in and year out without any new runners, there would obviously be a natural increase of 1 year for the mean ages. Because the mean ages are actually decreasing, this implies that there are younger runners in these top groups. It is not possible to say whether this is because of the older runners becoming slower (and dropping out of these top groups), a decrease in participation for the aging men, and/or an increase in the participation of younger runners.

Much research has been performed about the differences among the sexes in distance running (7,8,16,21). For the marathon, it has been proposed (38) that women will eventually

run as fast as men, although this has lately been challenged (16,25). Our study demonstrates that for these races in the United States from 2004 to 2011, there are increasing number of women entering 10-km running races compared with men. The passing of the 1972 Title IX educational amendment (Public Law No. 92–318, 86 Stat. 235) has widely been credited for increasing female participation in athletics. Whether or not this is still having an effect more than 1 generation after its inception is still up for debate. Women still have lower rates of physical activity than men (4), but factors such as higher education, age <40 years, nonminority status, and higher socioeconomic status are all associated with increased physical activity in women (3). For the races studied, all were increasing in the total number of participants. Recent statistics (28,29) suggest that the number of 10-km runners in the United States is increasing. The results of this study, however, do not directly address the overall participation rate in 10-km races, because the races included in the study were chosen explicitly because of their large size; other races (and conceivably the total number of 10-km participants in the United States) could just as easily be on the decline. It should be noted, however, the increase in female participation of 10-km races far outpaces the increase in male participation—in fact, as can be seen in our results, women now outnumber men in finishing these races, which changed in the 2006–2007 time frame. This also cannot be generalized to the overall population, but there is a convincing trend and it mimics similar running participation trends seen in other studies (15,18,33).

There is increased variability in the across-race winning time among women vs. men (r^2 = 0.371 vs. 0.864, respectively), which has also been seen in the marathon distance (15). Our study did not include individual racing data, so we are unable to make subject comparisons between the winners. However, it would be interesting to identify sex-associated predictors of trends in winning time. An explanation of the difference in competitiveness between the sexes has been an increased psychological competitiveness in men compared with women (7,8), which has not been verified by physiological studies (15). The surge of female participation has been shown to affect mostly the slower finishing times at other distances (8,15), but we show that at the 10- km distance, women tend to be improving among the top finishing times (the top 10 and top 100) compared with men. Moreover, the ratio of the sex of runners completing the courses in <1 hour is also decreasing, and at a faster rate than the ratio for overall participants. Why are the women getting faster in these races than the men? One common explanation is societal change over a physiological change (32) because more women of different socioeconomic and geographic backgrounds are able to enter these races. Another possibility is that the sheer increase in women participants of all speeds, as we have shown, allows for more potentially faster women to run these races. A final consideration would be that advances in exercise science and nutrition may differ among the sexes, although this has not been studied explicitly in runners.

There were some limitations to this study. First, the available data were pooled from large databases set up by each race director. These databases relied on participants to provide their own demographics, which can lead to errors at any step of the data entry process. Measures were taken to exclude obvious erroneous data, but there was no way of corroborating its accuracy. Several races stop timing at a certain point (before some of the last runners cross the finish line), which would have affected the number of total runners for each race; this

was one of the main reasons subhour participants were studied. Second, these races were selected based on their size; they do not represent all regions of the country, so geographic variability may exist. Third, these races all increased in size, which may not be the case for all large races; it is possible that other smaller races are having reductions in participation that could alter their trends in other ways. Fourth, we were unable to obtain data for all of the largest races in the United States. Finally, race-timing technology has evolved over this time period, which has allowed for more accurate timing and larger races—the effects of these changes cannot be quantified.

This study evaluates the trends and demographics for large 10-km races in the United States. Our study shows that for these races, the top men and women appear to be getting faster in completing a 10-km race. There is a dearth of literature available on middle-distance running despite its popularity. Our study showed that more people are finishing these races under 1 hour, with increasingly more women accomplishing this feat compared with men; however, an increasingly lower percentage of overall finishers are finishing in <1 hour. The fastest men are also increasingly younger, whereas women show no change in age over the years studied.

Practical Applications

Our results show the current state of the large 10-km running race in the United States. We demonstrate that these races are increasing in popularity and are becoming increasingly competitive. With the increase in popularity, there are proportionally more women and slower runners entering these races. Athletes and coaches can use these results to give their clients a performance benchmark and develop more women-specific training programs because women are now the majority of 10-km participants. The medical community can also learn more about the type of runner who is involved in these races, given their substantial annual participation, which can be used to better identify middle distance–specific running injuries in future studies.

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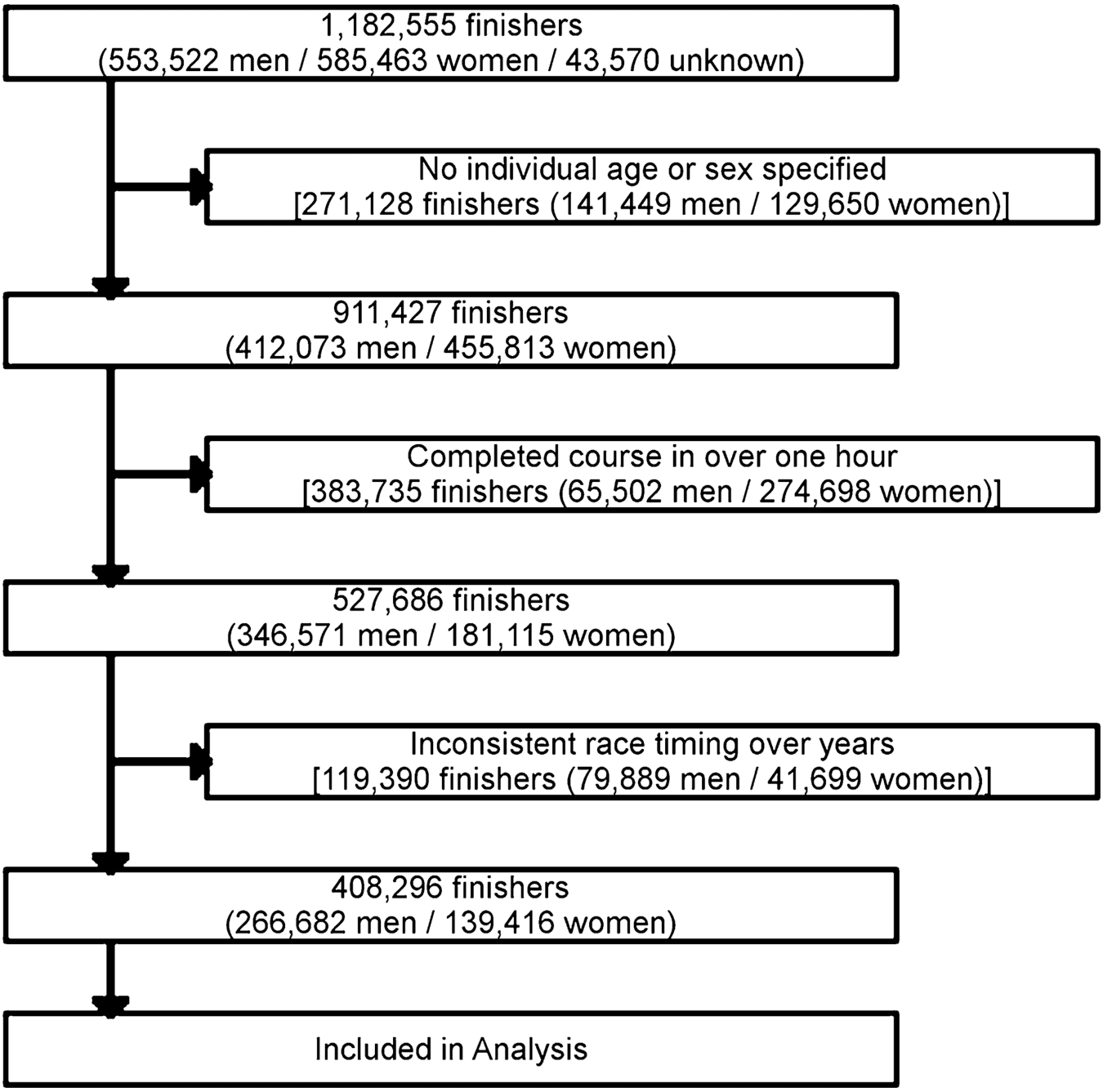

Figure 1.
Inclusion and exclusion flow diagram.

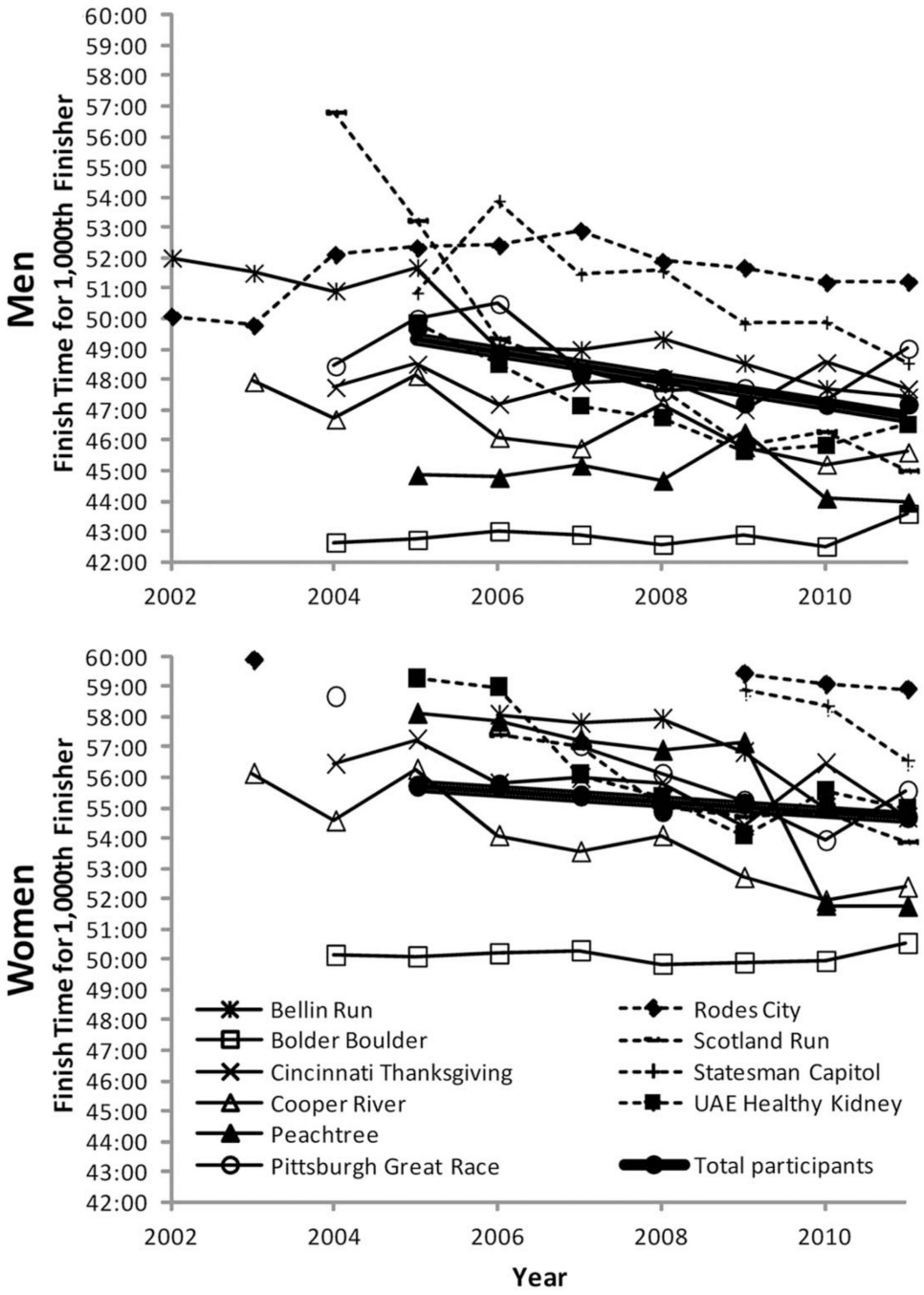

Figure 2.

Finish times for 1,000th-place finishers for men and women over 10-km races studied. Heavy line shows aggregate data of all the races (across-race data). Most races have decreases in the finish times of the 1000th-place finishers, and the aggregate data also follows this trend.

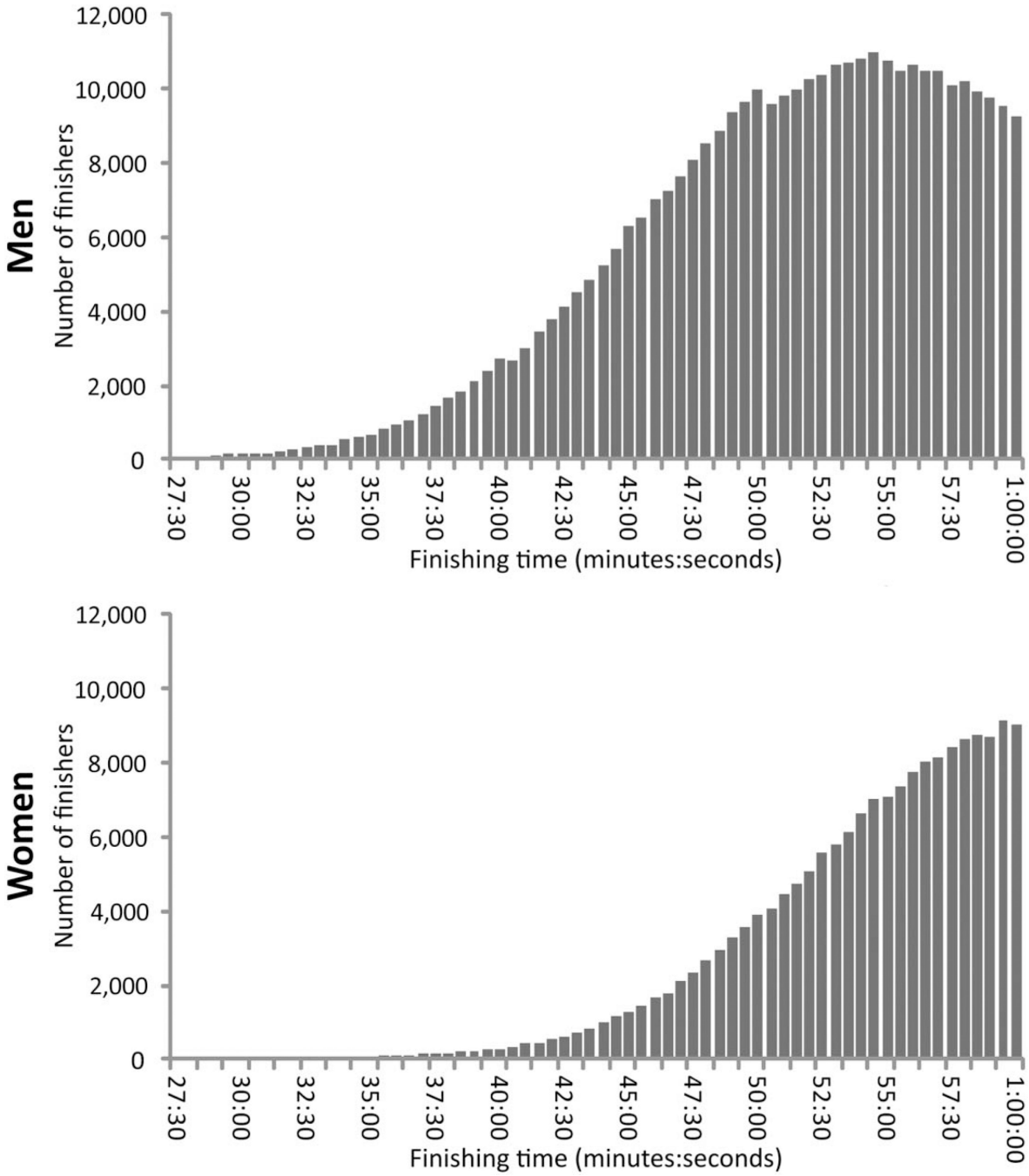

Figure 3.

Histograms of all subhour finishers for all 10-km races studied. The most common finish time for men was in the range of 54:30–55:30. The most common finish time for women was in the range of 58:30–59:30, although the analysis was stopped at 60:00, so this may not have been the most common finish time for all finishers.

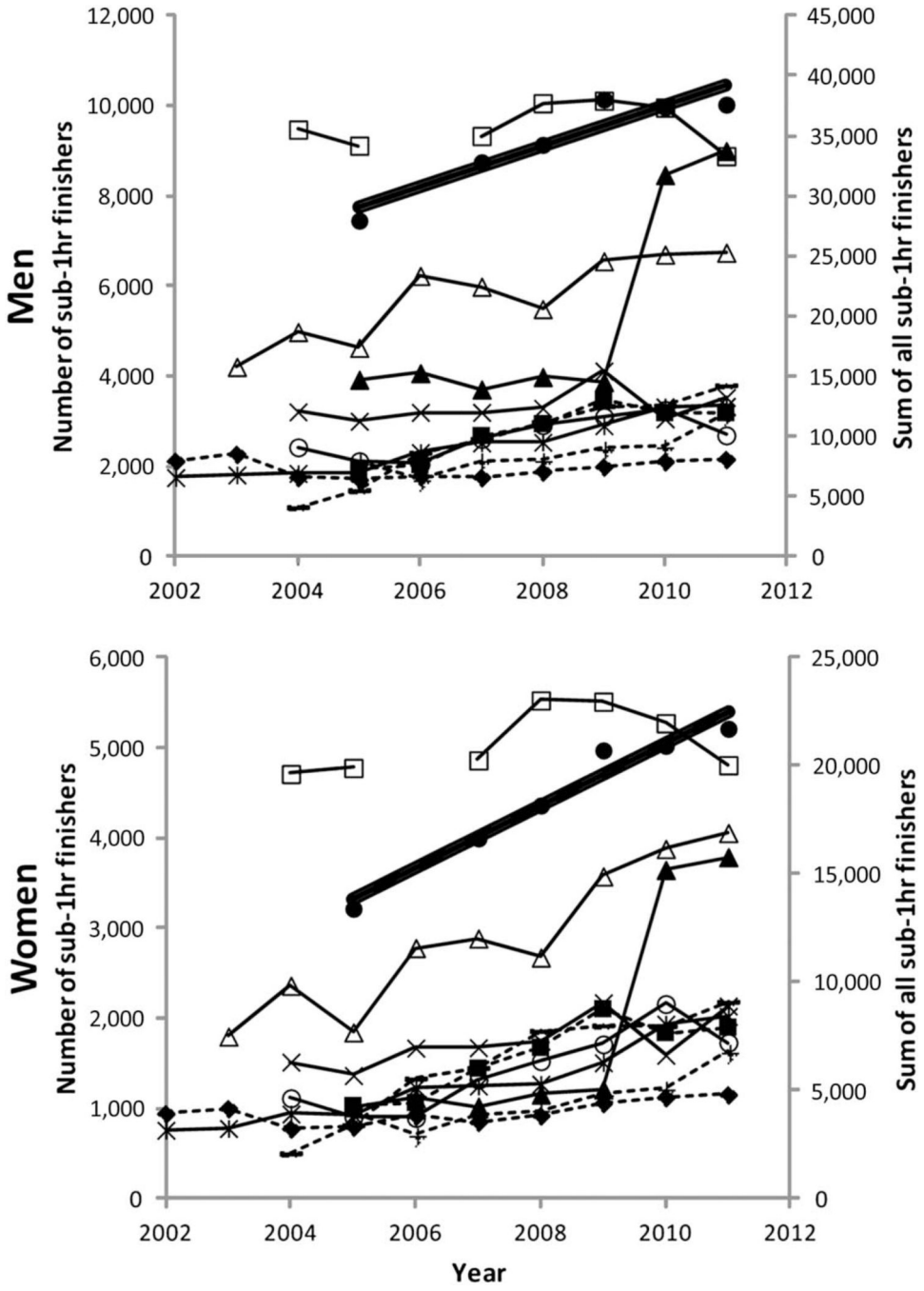

Figure 4.

Number of subhour finishers for 10-km races over time by sex. Aggregate data (heavy line) displayed on the right side *Y*-axis. For both men and women, there are increasingly more subhour finishers over time. Note the change in 2010 from the change in timing system for the AJC Peachtree Road Race, which was not included in the analysis but is displayed only to show the extent of change.

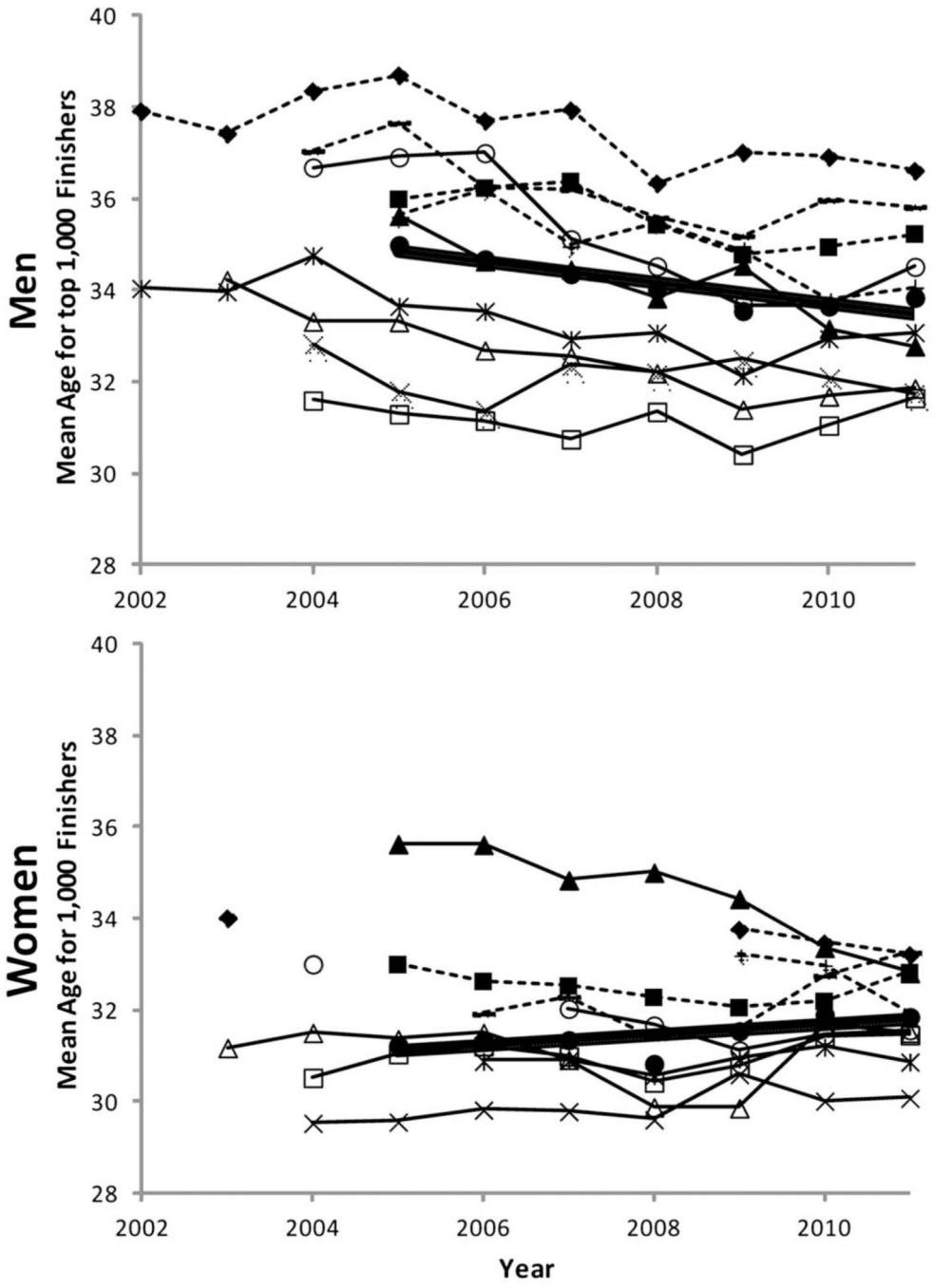

Figure 5.

Mean ages for top 1,000 finishers for men and women over 10-km races studied. Heavy line shows across-race data. Men show a decreasing mean age over time, whereas women show no significant change over all races.

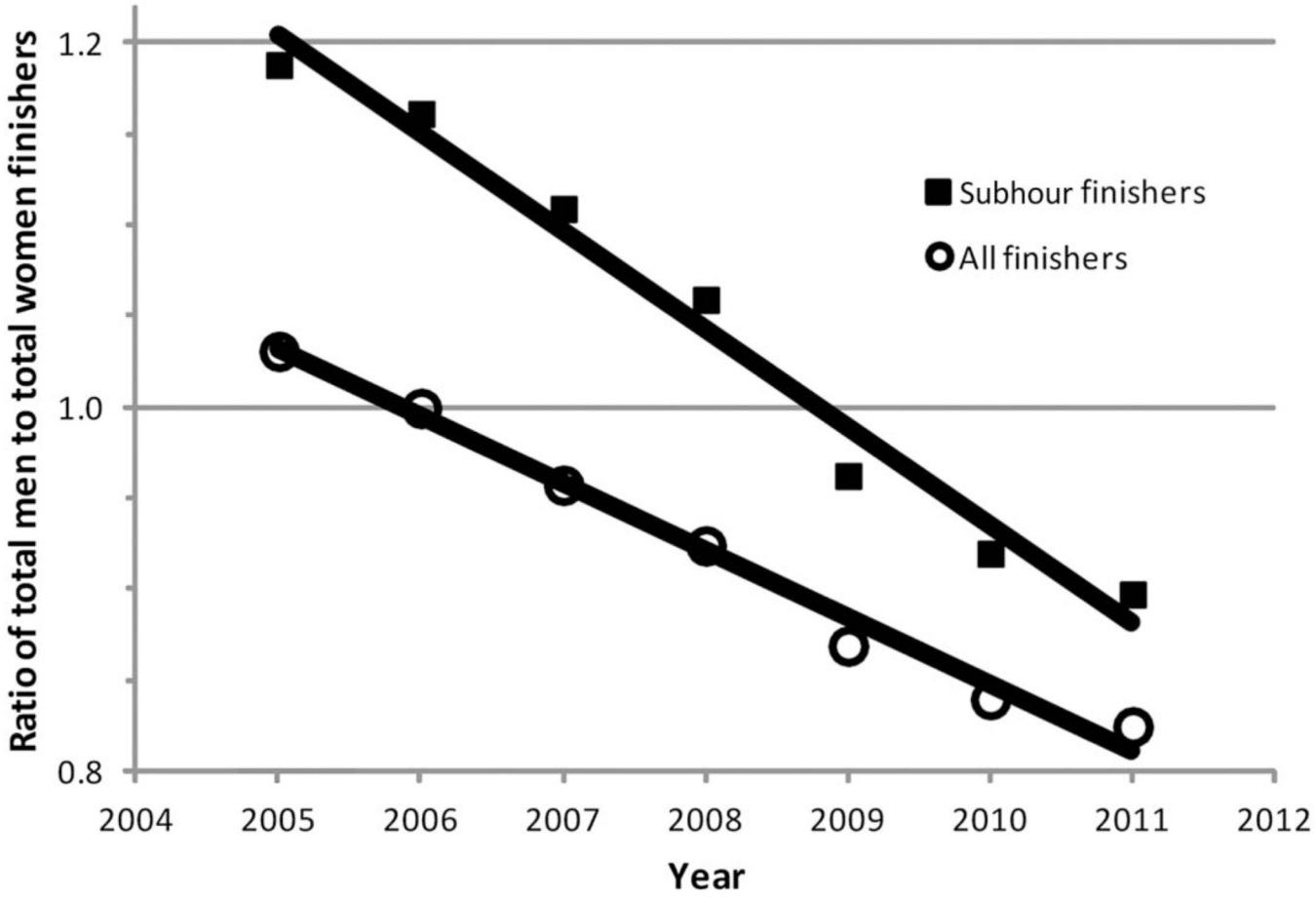

Figure 6.

Across-race analysis of ratio of men to women finishers for 10-km races studied. All finishers and all subhour finishers show a decreasing proportion of men to women over time. The slope for the subhour finishers is more negative than that of all finishers.

Table 1

Races included in analysis.

Race	Location	Number of 2011 finishers	Years analyzed
AJC Peachtree Road Race	Atlanta, GA	55,076	2004–2011
Dicks Sporting Goods Bolder Boulder	Boulder, CO	49,211	2004–2011
Cooper River Bridge Run	Charleston, SC	34,789	2003–2011
Bellin 10-km Run	Green Bay, WI	15,467	2002–2011
*Wharf-to-Wharf	Santa Cruz, CA	Unknown; 15,000 entries	1999–2011
Cincinnati Thanksgiving Day Race	Cincinnati, OH	13,884	2004–2011
Statesman Capitol 10 km	Austin, TX	10,178	2005–2011
Scotland Run	New York City, NY	8,493	2004–2011
Rodes City Run	Louisville, KY	7,958	2002–2011
Richard S. Caliguiri City of Pittsburgh Great Race	Pittsburgh, PA	7,881	2004–2011
UAE Healthy Kidney 10 km	New York City, NY	7,564	2005–2011

* Indicates that only the top 200 participants were included in the analysis.

Table 2

Demographics of participants in 10-km races analyzed.

	Men	Women	Total
All racers			
Total participants	553,522	585,463	1,138,985
Subhour finishing times			
Number of finishers	346,571	181,115	527,692
Age, median (interquartile range), y	36 (18)	31 (14)	
Time, median (interquartile range), min:s	51:28 (8:56)	54:39 (6:37)	

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Table 3

Faster finishing times over time for 10-km races studied.*

	Within-race		Across-race					
	p **(men)**	***p*** **(women)**	r^2 **(men)**	***p*** **(men)**	**Slope (men) min/y**	r^2 **(women)**	***p*** **(women)**	**Slope (women) min/y**
Top 1 time (winning time)	0.291	0.195	0.864	**0.002**	−0.108	0.371	0.146	−0.0602
Average top 10 times	**0.035**	**0.082**	0.994	**<0.001**	−0.152	0.822	**0.005**	−0.174
Average top 100 times	**0.002**	**0.020**	0.889	**0.001**	−0.183	0.843	**0.003**	−0.223
100th place time	**0.005**	**0.006**	0.780	**0.008**	−0.180	0.912	**0.001**	−0.238
Average top 1,000 times	**0.001**	**<0.001**	0.900	**0.001**	−0.301	0.794	**0.007**	−0.0833
1,000th place time	**0.003**	**<0.001**	0.902	**0.001**	−0.428	0.829	**0.004**	−0.173

*For “within-race” *p* values, a $p \leq 0.05$ indicates that the finishers within that particular group demonstrated faster finishing times over time, when controlling for race-to-race variation (e.g., linear regression was performed separately on each race then compared). The bold *p* values show statistical significance. For “across-race” *p* values, $p \leq 0.05$ indicates that the finishers within that particular group demonstrated faster finishing times over time and the slope indicates how many min/y were decreased from their average group finishing time (linear regression was performed on all finishers in all races each year).

Table 4

Younger finishing ages over time for 10-km races studied.*

	Within-race		Across-race					
	p **(men)**	***p*** **(women)**	r^2 **(men)**	***p*** **(men)**	**Slope (men) y/y**	r^2 **(women)**	***p*** **(women)**	**Slope (women) y/y**
Top finisher age	0.088	0.898	0.052	0.594	−0.150	0.370	0.147	−0.329
Top 10 average age	**0.017**	0.186	0.430	0.110	−0.309	0.021	0.758	−0.050
Top 100 average age	**<0.001**	0.085	0.935	**<0.001**	−0.349	0.007	0.859	0.011
Top 1,000 average age	**<0.001**	0.195	0.812	**0.006**	−0.224	0.438	0.105	0.114
Median age all finishers under 1 hr	**<0.001**	0.194	0.897	**0.001**	−0.318	0.087	0.521	−0.046

*For "within-race" *p* values, a $p \leq 0.05$ indicates that the finishers within that particular group were younger each year, when controlling for race-to-race variation (e.g., linear regression was performed separately on each race then compared). The bold *p* values show statistical significance. For "Across-race" *p* values, $p \leq 0.05$ indicates that the finishers within that particular group were younger each year, and the slope indicates how many years of age the finishers decreased per year (linear regression was performed on all finishers in all races each year).