Open Access Journal of Sports Medicine

Dovepress
open access to scientific and medical research

Open Access Full Text Article

ORIGINAL RESEARCH

Performance and age of African and non-African runners in half- and full marathons held in Switzerland, 2000–2010

This article was published in the following Dove Press journal:
Open Access Journal of Sports Medicine
24 July 2013
Number of times this article has been viewed

André Aschmann[1]
Beat Knechtle[2]
Marco Cribari[1]
Christoph Alexander Rüst[1]
Vincent Onywera[3]
Thomas Rosemann[1]
Romuald Lepers[4]

[1]Institute of General Practice and for Health Services Research, University of Zurich, Zurich, Switzerland; [2]Gesundheitszentrum St Gallen, St Gallen, Switzerland; [3]Department of Recreation Management and Exercise Science, Kenyatta University, Kenya; [4]Institut National de la Santé et de la Recherche Médicale, Faculty of Sport Sciences, University of Burgundy, Dijon, France

Background: Endurance running performance of African (AF) and non-African (NAF) athletes is investigated, with better performances seen for Africans. To date, no study has compared the age of peak performance between AF and NAF runners. The present research is an analysis of the age and running performance of top AF and NAF athletes, using the hypothesis that AF athletes were younger and faster than NAF athletes.

Methods: Age and performance of male and female AF and NAF athletes in half-marathons and marathons held in Switzerland in 2000–2010 were investigated using single and multilevel hierarchical regression analyses.

Results: For half-marathons, male NAF runners were older than male AF runners ($P = 0.02$; NAF, 31.1 years ± 6.4 years versus AF, 26.2 years ± 4.9 years), and their running time was longer ($P = 0.02$; NAF, 65.3 minutes ± 1.7 minutes versus AF, 64.1 minutes ± 0.9 minutes). In marathons, differences between NAF and AF male runners in age (NAF, 33.0 years ± 4.8 years versus AF, 28.6 years ± 3.8 years; $P < 0.01$) and running time (NAF, 139.5 minutes ± 5.6 minutes versus AF, 133.3 minutes ± 2.7 minutes; $P < 0.01$) were more pronounced. There was no difference in age (NAF, 31.0 years ± 7.0 years versus AF, 26.7 years ± 6.0 years; $P > 0.05$) or running time (NAF, 75.0 minutes ± 3.7 minutes versus AF, 75.6 minutes ± 5.3 minutes; $P > 0.05$) between NAF and AF female half-marathoners. For marathoners, NAF women were older than AF female runners ($P = 0.03$; NAF, 31.6 years ± 4.8 years versus AF, 27.8 years ± 5.3 years), but their running times were similar (NAF, 162.4 minutes ± 7.2 minutes versus AF, 163.0 minutes ± 7.0 minutes; $P > 0.05$).

Conclusion: In Switzerland, the best AF male half-marathoners and marathoners were younger and faster than the NAF counterpart runners. In contrast to the results seen in men, AF and NAF female runners had similar performances. Future studies need to investigate performance and age of AF and NAF marathoners in the World Marathon Majors Series.

Keywords: endurance, running, ethnicity, road race, gender difference

Introduction

Endurance running events, including the half-marathon and marathon distances, have become a social phenomenon.[1–3] This evolution was represented in an increasing participation trend for both men and women in all age groups among several competitive events all over the world.[1,4,5] For example, the number of participants in US marathons has increased during the last 36 years (1976–2011), going from 25,000 to 518,000 runners (+1.972%).[6] In addition, in running competitions more comparable to Swiss events, the number of athletes also increased; for example, for the Vienna City Marathon, the number of participants went from 6950 in 1990 to 36,157 in 2012.[7] The group of

Correspondence: Beat Knechtle
Facharzt FMH für Allgemeinmedizin, Gesundheitszentrum St Gallen, Vadianstrasse 26, 9001 St Gallen, Switzerland
Tel +41 71 226 82 82
Fax +41 71 226 82 72
Email beat.knechtle@hispeed.ch

runners increasing most is that of male and female athletes older than 40 years.[1,4] In 2011, women accounted for 41% of all finishers in US marathons (increasing from 10% in 1980), and master athletes accounted for 46% (increasing from 26% in 1980).[6]

One of the most interesting observations in endurance running events is the African (AF) dominance seen in the last decades.[8–10] For example, the first non-African (NAF) man in the International Association of Athletics Federations marathon all-time list placed at 32 (Khalid Khannouchi, USA, 2002). The first 31 places were held by AF runners from Kenya, Ethiopia, and Morocco.[11] Similarly, in the half-marathon distance, the best NAF runner in the all-time list is ranked only in position 38 (Marilson dos Santos, Brazil, 2007). The top positions were taken by runners from Kenya, Ethiopia, and Eritrea.[11]

Recent studies have investigated the reasons for AF long-distance runners' success. Different authors have analyzed several potential reasons for this overwhelming domination, such as physiological characteristics,[10] social factors,[9] nutritional differences between Kenyan/Ethiopian diets and mostly recommended macronutrient intake for endurance athletes,[12,13] genetic predisposition,[10,14] development of a high maximal oxygen uptake and/or running economy as a result of extensive running in childhood,[15,16] living at high altitude,[16,17] differences in skeletal-muscle-fiber composition,[18] differences in oxidative enzyme profile,[19] psychological advantage,[20] and higher motivation to achieve economic success.[16] Until now, it seems that East African superiority in long-distance running is not based on a unique factor but rather, is a result of a combination of the factors mentioned earlier.[21]

Regarding the dominance of AF runners in road running events, we questioned whether the age of peak performance differed between AF and NAF athletes. For elite athletes, marathon performance actually peaked when runners were between 25 and 35 years old.[3,22] A recent study investigating the age of the top five men and women in the seven marathons of the World Marathon Majors Series indicated a similar age of peak marathon performance for men of 28.9 ± 3.8 years, and for women of 29.8 ± 4.2 years.[23] In their investigation, Hunter et al did not investigate the ethnicity of top runners.[23] To the best of our knowledge, no data exist regarding a potential difference in the age of peak running performance between AF and NAF runners. Therefore, the goals of the present study were to analyze the running performance of the best female and male AF versus the best female and male NAF runners in half-marathons and marathons in a single country (Switzerland) between 2000 and 2010, and to compare the age of peak running performance of the best AF and NAF half-marathon and marathon runners during the same period.

Materials and methods

All procedures used in the study met the ethical standards of the Swiss Academy of Medical Sciences and were approved by the Institutional Review Board of Kanton St Gallen, Switzerland, with a waiver of the requirement for informed consent of the participants, given that the study involved the analysis of publicly available data.

Data sampling

Half- and full marathons from Switzerland were examined because of the completely archived and easily accessible data. Complete data for this study were obtained from the race directors. All officially held road-race half- and full marathons in Switzerland during 2000–2010 with an official ranking were analyzed, for a collective total of 145 half-marathons and 30 full marathons. Mountain races were excluded because of their different conditions (ie, temperature, altitude difference during race) compared with international events such as the Olympic Games or World Championships. All runners were analyzed regarding age, ethnicity (as declared at registration), participation, and performance (ie, running time).

Data analysis

In total, data were available for 313,173 athletes (Table 1). These athletes were divided into eight groups. First, we examined the changes in the number of male and female participants in half-marathons and marathons during the studied period. Second, to find trends in the development of the top performance and the age of the fastest runners for all marathons and half-marathons taking place in the same year,

Table 1 Total number of African and non-African finishers on both half- and full marathons in Switzerland, from 2000 to 2010

Characteristics	Finishers
Half-marathons	
Non-African men	162,288
African men	169
Non-African women	64,230
African women	67
Marathons	
Non-African men	71,200
African men	183
Non-African women	14,982
African women	54
Total	313,173

Note: We excluded 708 runners from the analysis due to lack of information about race time or age.

all data were pooled. Data for all half-marathons and marathons, and the performance and age of the top five overall male and female AF and NAF runners for every year were analyzed. Because of the low number of AF runners, it was not possible to include a higher number of annual runners (eg, top 10 or top 20 runners per year) into the analyses. Subsequently, the five values from the same year were pooled to calculate the mean ± standard deviation (SD). For the marathons held in 2000, for both AF men and women, data for fewer than five athletes existed. Therefore, male and female AF marathoners from 2000 were excluded from analysis. However, data from 2000 from NAF marathoners and for both NAF and AF half-marathoners were included to maximize data for statistical analyses.

Statistical analysis

To increase the reliability of data analyses, each set of data was tested for a normal distribution, as well as for homogeneity of variances before the statistical analyses. A normal distribution was tested using a D'Agostino and Pearson omnibus normality test, and homogeneity of variances was tested using a Levene's test. Linear regression analysis was used to find significant differences in the development of a variable over the years. A hierarchical regression model was used to avoid the effect of a cluster effect on results in case one athlete finished more than once in the annual top five. Furthermore, regression analyses of performance were corrected for the age of the athletes to prevent a misinterpretation of the age effect as a time effect. For both sexes and both running distances, a two-way analysis of variance (ANOVA) (ethnicity × years) was performed to test for the interaction between ethnicity and time on performance. The running performance and the age of AF versus NAF runners over the years were compared using a subsequent Bonferroni post hoc analysis. Statistical analyses were performed using IBM SPSS Statistics (version 19; IBM Corporation, Armonk, NY, USA) and GraphPad Prism (version 5; GraphPad Software, Inc, La Jolla, CA, USA). Significance was accepted at the $P < 0.05$ level (two-sided for *t*-tests). Data in the text and figures are given as mean ± SD.

Results

Participation trends

The analyzed events averaged at 13 half-marathons per year (range, 9–20 half-marathons) and three full marathons per year (range, 1–5 full marathons), respectively. During 2000–2010, the number of male and female finishers in half-marathons increased over the years, going from 2904 to 8690 (+199%) for women ($r^2 = 0.98$; $P < 0.01$) and 9333 to 21,583 (+131%) for men ($r^2 = 0.98$; $P < 0.01$) (Figure 1). The male/female ratio (m/w-ratio) decreased during the 11-year period from 3.2 to 2.5. After the number of marathon finishers peaked in 2005 (9771 men and 2156 women; m/w-ratio, 4.5), the number of finishers decreased to 7050 (–28%) men and 1357 (–37%) women (m/w-ratio, 5.2). The percent distribution of AF and NAF athletes is presented in Figure 2. AF women and men accounted for less than 1% of all finishers. On average, 15 AF men and six AF women participated annually in half-marathons. In marathons, the mean annual number of AF participants was 18 for men and five for women, respectively. At least 67% of AF athletes (male half-marathoners) were Kenyan and Ethiopian runners.

Performance trends

During the 11-year period, the marathon performance time of the annual top five NAF women decreased significantly, by 6.8%, going from 174.0 minutes ± 7.5 minutes in 2000 to 162.2 minutes ± 5.4 minutes in 2010 (Figure 3), including when corrected for age (Table 2). Across years, the annual top five male NAF marathoners improved their running time significantly, going from 147.0 minutes ± 5.1 minutes in 2000 to 140.4 minutes ± 0.5 minutes in 2010 (Figure 3), both uncorrected and corrected for age (Table 2). In contrast, running time of the annual top five female AF marathoners showed no change during the studied period (Table 2 and Figure 3). The annual top five male AF marathoners were significantly faster running across years, with and without correction for age (Table 2), with times of 137.0 minutes ± 3.6 minutes in 2001 versus 133.2 minutes ± 2.2 minutes in 2010 (Figure 3). The half-marathon performance time for the uncorrected regression analysis showed no significant change over the years independent of the sex and origin of the runners (Table 2 and Figure 3). When corrected for age, only the running time of the annual top five male NAF half-marathoners increased significantly across years (Table 2), going from 64.0 minutes ± 0.0 minutes in 2000 to 65.8 minutes ± 0.8 minutes in 2010 (Figure 3).

The mean male finishing times were significantly lower for the best AF runners compared with those of the best NAF runners for both the half-marathon (–1.9%; $P = 0.02$) and marathon (–4.7%; $P < 0.01$) (Table 3). The two-way ANOVA showed an effect of ethnicity on race time that explained 18.3% ($F = 64.2$; $P < 0.0001$) of total variance in male half-marathoners and 89.3% ($F = 812.7$; $P < 0.0001$) in male marathoners. In women, mean running

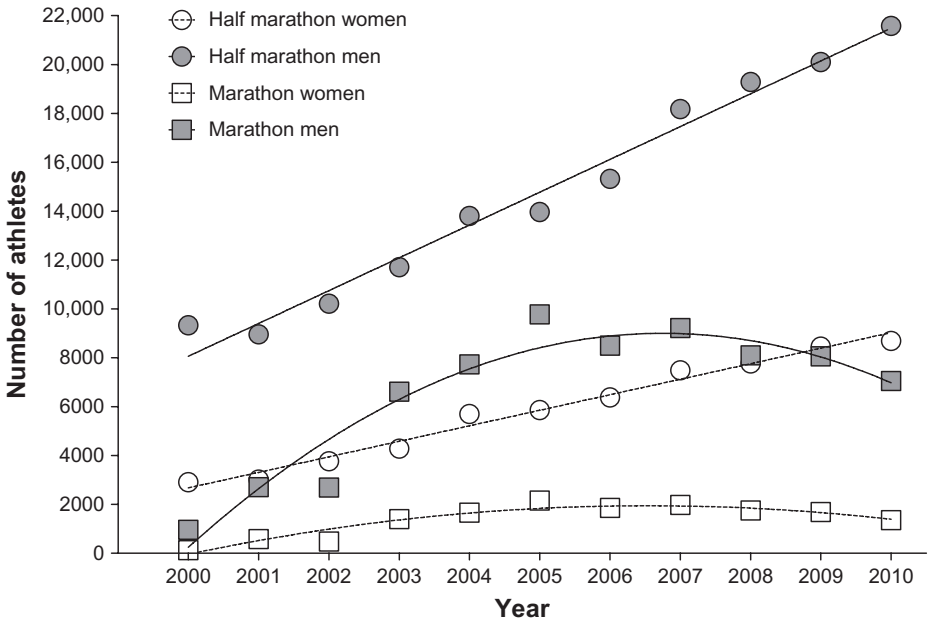

Figure 1 Changes in the number of female and male participants in full and half-marathons held in Switzerland during 2000–2010.
Note: Because of the curvilinear manner of men and women marathon runners, a nonlinear regression was performed.

times did not differ between ethnicities ($P > 0.05$) for both half-marathon (NAF, 75.0 minutes ± 3.7 minutes versus AF, 75.6 minutes ± 5.3 minutes) and marathon (NAF, 162.4 minutes ± 7.2 minutes versus AF, 163.0 minutes ± 7.0 minutes) (Table 3). The two-way ANOVA performed for female athletes showed an effect of ethnicity on race time explaining 75.9% ($F = 574.1$; $P < 0.0001$) in female marathoners, but not in female half-marathoners, with 0.90% ($F = 1.30$; $P = 0.26$) of total variance.

Age of the fastest runners

The age of half- and full marathoners showed no change over the years for both male AF and NAF runners (Figure 4). The mean age of the male runners was significantly higher for NAF than for AF runners in both half-marathon (NAF, 31.1 years ± 6.4 years versus AF, 26.2 years ± 4.9 years; $P = 0.02$) and marathon (NAF, 33.0 years ± 4.8 years versus AF, 28.6 years ± 3.8 years; $P < 0.01$) (Table 3). For female half-marathoners, age showed no change across years for both AFs and NAFs. In addition, no difference in age was found between female AF and NAF half-marathoners ($P > 0.05$) (Table 3). In marathons, the mean age of the annual top five female AF increased significantly from 25.0 years ± 1.0 years in 2001 to 38.0 years ± 2.8 years in 2010 (Figure 4). The mean age of the corresponding NAF group remained unchanged over the years ($P > 0.05$). For the marathon, the top five female NAF runners were significantly older than the AF counterpart (NAF, 31.6 years ± 4.8 years versus AF 27.8 years ± 5.3 years; $P = 0.03$) (Table 3).

Discussion

The main findings of the present study were better running performances for male AF half-marathoners and marathoners compared with non-AF athletes and younger ages for the best AF male half-marathoners, AF male marathoners, and AF female marathoners compared with their NAF counterparts.

Best African runners were younger than the best non-African runners

An important finding of the present study was the younger age of the top five AF runners compared with NAF runners in men's half-marathons, in men's marathons, and in women's marathons. This constitutes a novel finding, although it must be interpreted with caution. Indeed, the rate of overall finishers increased over the years, but the percentage of AF runners remained very small (<1% of overall finishers). In addition, the mean age of the female AF marathoners increased significantly across years, whereas the corresponding value of the female NAF group remained stable. Hence, when comparing these groups, a difference in the age of peak performance is highly questionable. Nonetheless, male AF half- and full marathoners were younger than their NAF counterparts, whereas the mean age of these four groups did not change during the 2000–2010 period.

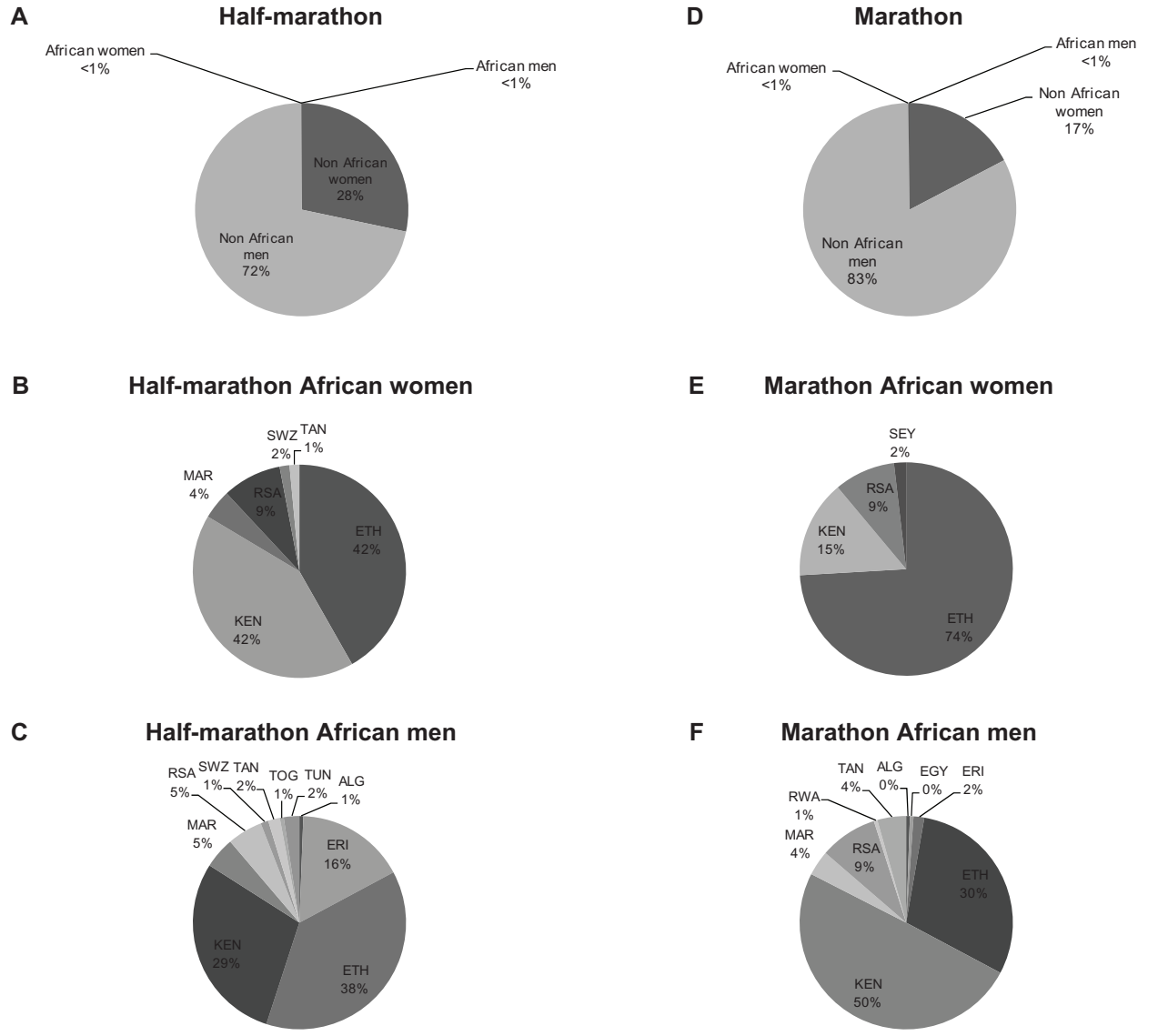

Figure 2 Distribution of total (**A** and **D**), African women (**B** and **E**), and African men (**C** and **F**) participating in half-marathons (**A**–**C**) and in marathons (**D**–**F**) in Switzerland during 2000–2010.

Abbreviations: KEN, Kenya; EGY, Egypt; ETH, Ethiopia; MAR, Morocco; RSA, South Africa; SWZ, Swaziland; TAN, Tanzania; ERI, Eritrea; TOG, Togo; TUN, Tunisia; ALG, Algeria; RWA, Rwanda; SEY, Seychelles.

A possible reason for the younger age of AF finishers may be their motivation. Approximately 50% of the Kenyan and 39% of the Ethiopian population live below the poverty line.[10] Therefore, AF athletes compete in endurance running events mostly for economic reasons (33%) in addition to other reasons such as tradition (18%), talent (18%), and Olympic glory (14%).[16] Njororai also has presented the financial motivation of Kenyan athletes competing in endurance running events.[24,25] These studies described Kenyan athletes migrating to and running for other countries in the hopes of having a better chance of earning a living than in Kenya. Furthermore, Kenyan runners have an easier entrance to international competitions because there is less governmental opposition with the large pool of excellent runners in Kenya.[24] However, not a single Kenyan athlete participated at the Boston marathon until prize money was introduced in 1986.[25] These financial incentives might result in AF athletes competing at younger ages because of the possibility of earning enough money early in life to support their families.

Onywera et al[16] and Wilber and Pitsiladis[10] report that most of the AF athletes come from isolated parts of the two countries, such as the Rift Valley in Kenya and the Arsi region in Ethiopia. Our data set lacks the exact origin of the AF athletes, although the ethnic distribution of the AF finishers in our study does show a dominance of Kenyan and Ethiopian runners. Running schools in these two countries

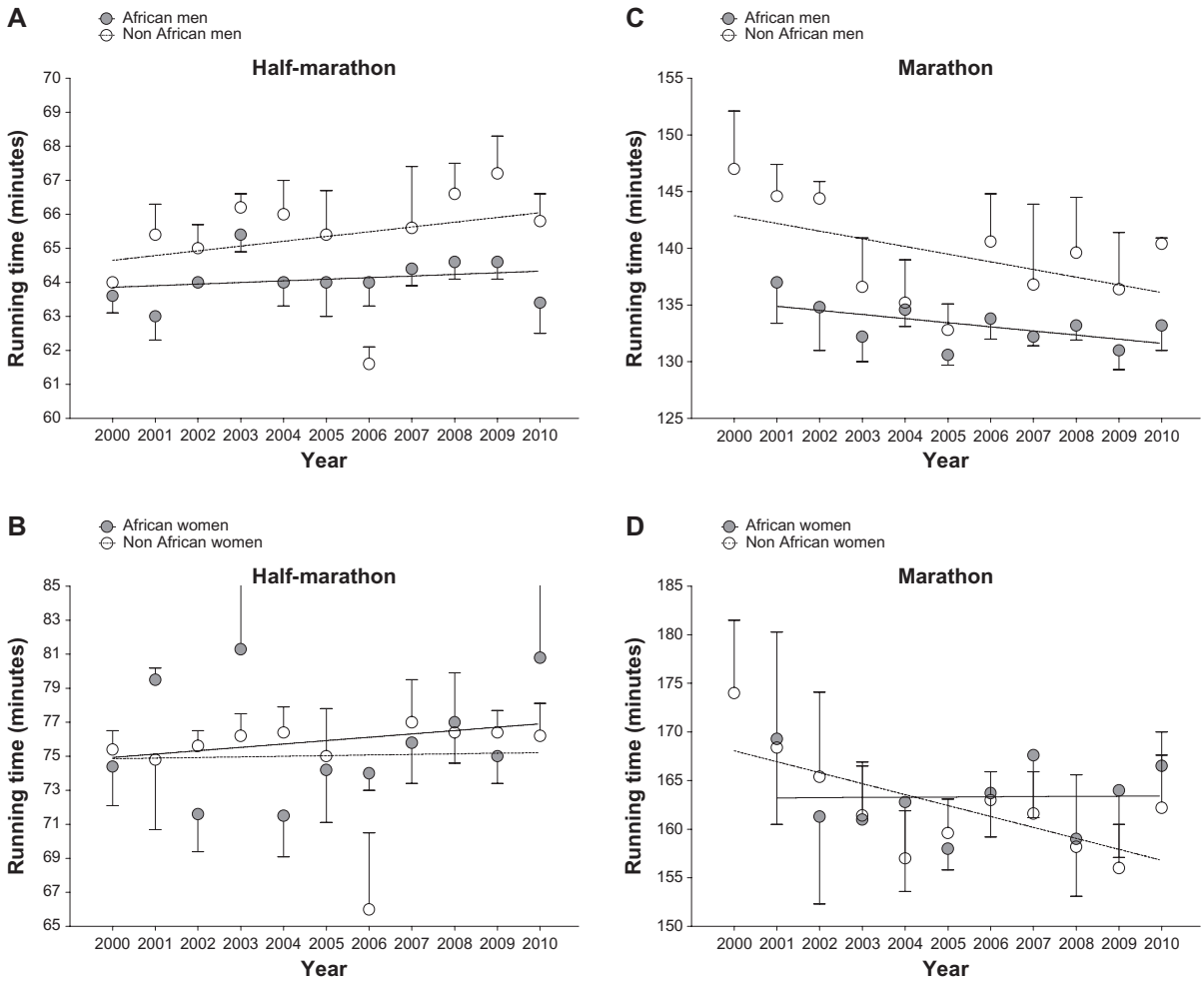

Figure 3 Changes in race time of the top five athletes from 2000–2010 for men (**A** and **C**) and women (**B** and **D**) in half-marathons (**A** and **B**) and marathons (**C** and **D**).

have created many international elite athletes by exposing young runners daily to the tradition of Kenyan and Ethiopian running.[10] As a result of that exposure it is perhaps possible that these running schools want to measure their students early-on against NAF runners. With this approach, they may be able to create their own national athletes who are competitive in championships or Olympic Games. This may also explain the shift to AF participants' younger age in the half-marathons and marathons in Switzerland. Despite this potential age-induced bias, it remains unclear why there was a significant difference in the age of peak performance except for women in half-marathons.

Only the mean age of the top five female AF marathoners increased over the years. One reason may be that most of the AF women participated every year, as the increase in mean age of +1.3 years/year signals. In our investigation, marathon repeaters were not acknowledged. Hence, it is possible that the same athletes participated in consecutive races and were ranked top in most of the years. Leyk et al show in their analysis of marathon runners aged 20 years to 80 years that about 35% of female participants and 45% of male participants were marathon repeaters.[26] Certainly, multiple participation of a single athlete may have occurred in the other groups, too. However, the effect in the group of AF women may have been greater because of the lower number of participants, with 57 athletes in eleven years.

Differences in finishing times between African and non-African runners

AF men were running significantly faster than NAF men in both the half-marathon (−1.8%) and marathon (−4.4%). These findings corroborate the current AF dominance in long-distance running events.[9,21] Several investigations tried to explain the AF superiority. Comparing well-trained AF and Caucasian runners, AF athletes seemed not to have a higher maximum uptake but, rather, a better running economy and a lower blood lactate concentration at very high intensities of exercise.[15] Several studies attempted to

Table 2 Multilevel regression analyses for change in performance across years (model 1) and with correction for age (model 2)

Model	ß	SE (ß)	Stand ß	T	P
Female African marathoners					
1	0.034	0.414	0.013	0.082	0.935
2	0.042	0.476	0.016	0.088	0.930
Male African marathoners					
1	−0.362	0.124	−0.389	−2.928	0.005
2	−0.365	0.126	−0.392	−2.899	0.006
Female African half-marathoners					
1	0.296	0.249	0.175	1.192	0.240
2	0.240	0.248	0.142	0.968	0.338
Male African half-marathoners					
1	0.047	0.037	0.174	1.287	0.204
2	0.047	0.037	0.175	1.273	0.209
Female non-African marathoners					
1	−1.125	0.271	−0.495	−4.147	<0.001
2	−1.135	0.274	−0.499	−4.139	<0.001
Male non-African marathoners					
1	−0.676	0.227	−0.379	−2.981	0.004
2	−0.547	0.220	−0.307	−2.490	0.016
Female non-African half-marathoners					
1	0.036	0.159	0.031	0.229	0.820
2	0.101	0.152	0.087	0.665	0.509
Male non-African half-marathoners					
1	0.140	0.070	0.264	1.994	0.051
2	0.178	0.071	0.337	2.526	0.015

Abbreviations: *ß*, not standardized regression coefficient; SE(*ß*), standard error of *ß*; Stand *ß*, standardized regression coefficient; T, result (*t*-value) of *t*-test of regression coefficient; *P*, *P*-value of *t*-test of regression coefficient.

find a single advantage of the AF athletes in running events; for example, nutritional benefits,[9,12,13] living and training at higher altitudes,[16,17] skeletal-muscle-fiber composition,[18] a psychological advantage (such as knowing that there may be a situational advantage to winning; stereotype threat),[20] and a higher motivation to achieve economic success.[16] Concerning some performance genes,[27] no differences were detected.[14] Wilber and Pitsiladis acknowledge in their review about AF prowess in endurance running that there must be numerous factors playing together, such as living and training at altitude, enhanced biomechanical and metabolic efficiency, and psychological motivation to achieve success.[10] Further, Hamilton describes a domination in endurance running by Scandinavians in the early 20th century and by Australasians in the 1950s and 1960s.[28] Hamilton did not exclude the possibility that in a few years, another nationality may take the reins, considering that other nations are not accepting the AF dominance because of factors they cannot influence.[28]

Table 3 Race time and age of top five non-African and African runners during 2000–2010, expressed in mean ± SD

	Race time (minutes)	Age (years)
Half-marathons		
African men	64.1 ± 0.9	26.2 ± 4.9
African women	75.6 ± 5.3	26.7 ± 6.0
Non-African men	65.3 ± 1.7*	31.1 ± 6.4*
Non-African women	75.0 ± 3.7	31.0 ± 7.0
Marathons		
African men	133.3 ± 2.7	28.6 ± 3.8
African women	163.0 ± 7.0	27.8 ± 5.3
Non-African men	139.5 ± 5.6*	33.0 ± 4.8*
Non-African women	162.4 ± 7.2	31.6 ± 4.8*

Notes: *Significantly different from African counterparts (same sex and running distance); $P < 0.05$.

A significant improvement of running times across years, when corrected for age, was observed in male AF and NAF marathoners and in female NAF marathoners. As the mean age of these groups remained stable over the same period, this may mean that the best runners were not yet close to their performance limits. This finding is supported by the investigation of Nevill and Whyte, who analyzed the evolution of world records during the 20th century and predicted a peak running world record.[29] Another study examined the time progression in male marathons from 1969 to 2010 and concluded that the limits of male marathon runners' performance has not yet been reached.[30]

Increasing performance was mostly seen for the female NAF marathoners, but the reasons for this finding are unclear. For example, better competitive training of women in recent

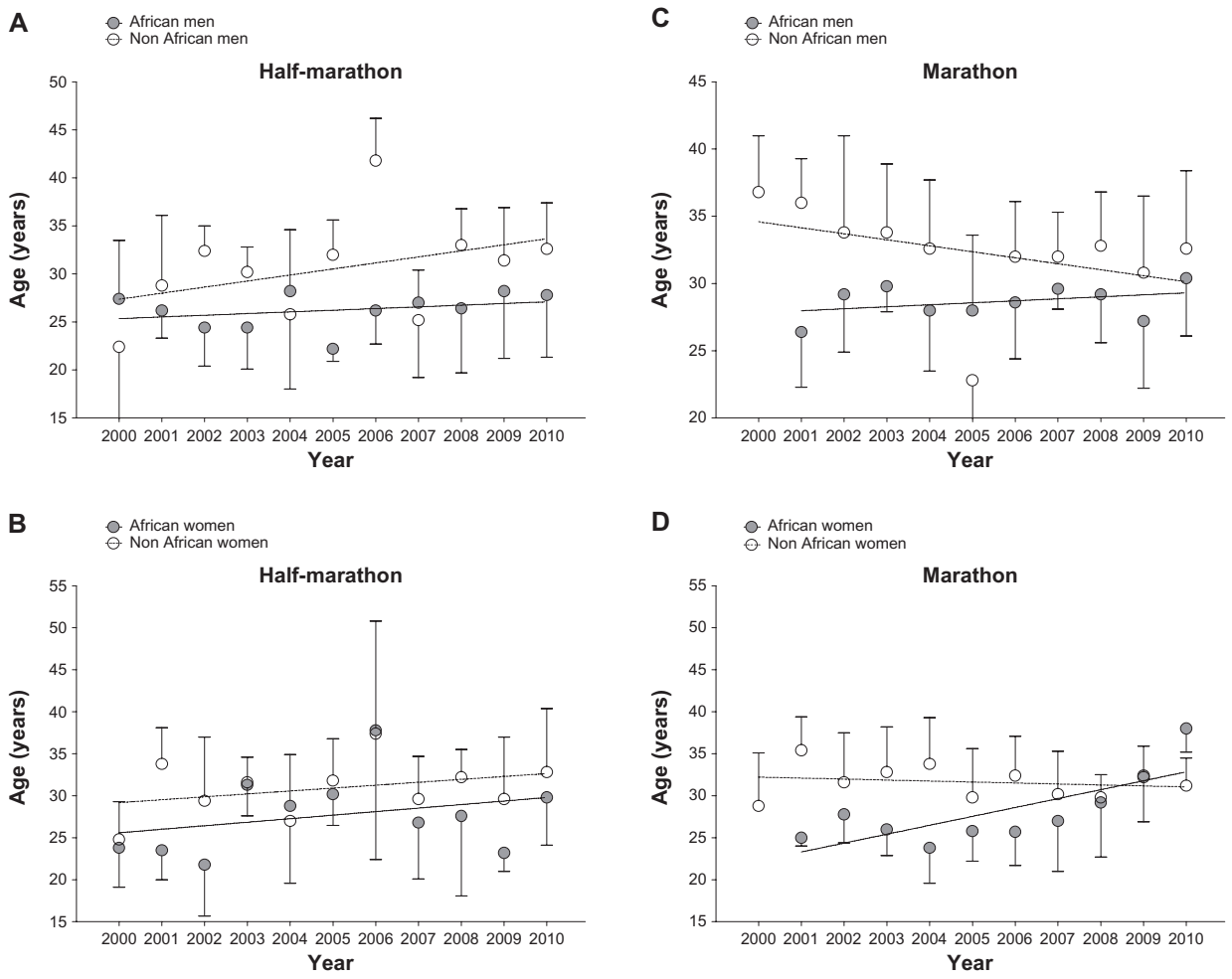

Figure 4 Changes in age of the top five athletes from 2000 to 2010 for men (**A** and **C**) and women (**B** and **D**) in half-marathons (**A** and **B**) and marathons (**C** and **D**).

years may have led to this improvement. Furthermore, Hunter and Stevens found a correlation between participation number and finishing times.[5] Their investigation explained about one third of the difference between sexes in running velocity by the lesser number of female compared with male finishers.[5] This effect may also have taken place in the races in Switzerland. For female marathoners, participation increased until 2005. This larger number of participants might be correlated with the improvement in female running performance until 2005. However, it remains unclear why the improvement continued after 2005 despite the decreasing number of participants in female marathons from 2005 to 2010.

The running times of the female AF marathoners showed no change across years. As the mean age of the top five female AF runners increased during 2001–2010, it seemed that there was a minor age-related decline in running performance that is in line with the findings of Celie et al.[31] In half-marathons, running time across years did not differ significantly for all groups except for male NAF half-marathoners, with a correction for age. As the mean age in all the groups did not differ, one can assume that the half-marathoners have reached their limits. On the one hand, this finding is corroborated by the results of Lepers and Cattagni, showing that running times of athletes aged less than 60 years plateaued in the New York City Marathon of the 1980–2009 period.[4] On the other hand, these results are in contrast to the marathon data from the present study and to investigations already described in previous sections, which report an ongoing improvement of endurance runners' performance.[29,30]

Increasing participation over the years in half-marathon, but not in marathon

The results showed an increasing finisher rate in half-marathons, whereas in marathons, the finisher rate increased until 2005 for both men and women but decreased thereafter. Regarding the existing literature, an increase in participants was expected, but not the decrease in marathon participation observed after 2005. Marathon participation also decreased

in the Vienna City Marathon in 2004 but increased again afterward compared with the marathons in Switzerland.[7]

As a first approach to explaining this trend, we could consult the investigation of Leyk et al, who reported in their study about performance, training, and lifestyle parameters of marathon runners that 72% of all athletes rated themselves as health and recreational runners.[26] In addition, more than 25% of the marathon finishers aged 50 to 69 years began running within the previous five years.[32] Given that physical activity has positive effects on health,[33] this might indicate an increased awareness of the effect of health and physical activity on morbidity.[34] Second, in a half-marathon, the effort is smaller than in a marathon. This may illustrate a different anthropometry of half-marathoners and marathoners. Half-marathoners had a higher body mass and a higher percentage of body fat compared with marathoners.[35] In addition, half-marathoners had shorter training sessions than marathoners.[35] Thus, successful participation in a half-marathon might not take up as much of one's leisure time compared with marathon running. Third, newcomers might prefer finishing half-marathons in less time to running a marathon with dissatisfactory race times.[35] The decline in participation in marathons after 2005 could possibly be seen in this context, too, whereas athletes who already started at a marathon, and with longer race times than expected, might start only in half-marathons in the following years to improve their performance and adjust slowly to endurance running.

Limitations

Factors that seem to influence performance, such as weather,[36] hydration strategies during competition,[37] anthropometry,[38] or training variables,[39] have not been integrated in this study. The small number of AF athletes constitutes the main limitation of the present investigation. Considering this small AF group, further research is needed to gain more insight about a possible difference between AF and NAF athletes regarding the age of peak endurance running performance.

Conclusion

Male AF runners were faster than NAF runners in both half- and full marathons. However, in contrast to men, AF and NAF female runners had similar performances. This is the first study investigating the age of peak endurance running performance between AF and NAF athletes. The results show that the fastest male AF half-marathoners and marathoners, and fastest female AF marathoners, were younger than their NAF counterparts in marathons held in Switzerland. It is questionable whether these results could be generalized to greater events. Thus, it would be interesting to analyze the age of the fastest AF and NAF runners in other countries or other races in the world and to compare them with these results from Switzerland.

Disclosure

The authors report no conflicts of interest in this work.

References

1. Jokl P, Sethi PM, Cooper AJ. Master's performance in the New York City Marathon 1983–1999. *Br J Sports Med*. 2004;38(4):408–412.
2. Burfoot A. The history of the marathon: 1976-present. *Sports Med*. 2007;37(4–5):284–287.
3. Trappe S. Marathon runners: how do they age? *Sports Med*. 2007; 37(4–5):302–305.
4. Lepers R, Cattagni T. Do older athletes reach limits in their performance during marathon running? *Age (Dordr)*. 2012;34(3):773–781.
5. Hunter SK, Stevens AA. Sex differences in marathon running with advanced age: physiology or participation? *Med Sci Sports Exerc*. 2013;45(1):148–156.
6. http://www.runningusa.org [homepage on the Internet]. Running USA's Annual Marathon Report. Colorado Springs, CO: Running USA; 2013. Available from: http://www.runningusa.org/index.cfm?fuseaction=news.details&ArticleId=332&returnTo=annual-reports. Accessed September 17, 2012.
7. http://www.vienna-marathon.com [homepage on the Internet]. Vienna City Marathon Statistics. Vienna: Vienna City Marathon; 2012. Available from: http://www.vienna-marathon.com/?url=geschichte/06_statistik/08_finisher. Accessed April 26, 2013.
8. Larsen HB, Christensen DL, Nolan T, Søndergaard H. Body dimensions, exercise capacity and physical activity level of adolescent Nandi boys in western Kenya. *Ann Hum Biol*. 2004;31(2):159–173.
9. Onywera VO. East African runners: their genetics, lifestyle and athletic prowess. *Med Sport Sci*. 2009;54:102–109.
10. Wilber RL, Pitsiladis YP. Kenyan and Ethiopian distance runners: what makes them so good? *Int J Sports Physiol Perform*. 2012;7(2):92–102.
11. http://www.iaaf.org [homepage on the Internet]. IAAF men all-time list outdoor half-marathon and marathon. Monaco: International Association of Athletics Federations. Available from: http://www.iaaf.org/records/toplists/road-running/half-marathon/outdoor/men/senior. Accessed September 17, 2012.
12. Onywera VO, Kiplamai FK, Boit MK, Pitsiladis YP. Food and macronutrient intake of elite Kenyan distance runners. *Int J Sport Nutr Exerc Metab*. 2004;14(6):709–719.
13. Beis LY, Willkomm L, Ross R, et al. Food and macronutrient intake of elite Ethiopian distance runners. *J Int Soc Sports Nutr*. 2011;19;8:7.
14. Scott RA, Pitsiladis YP. Genotypes and distance running: clues from Africa. *Sports Med*. 2007;37(4–5):424–427.
15. Weston AR, Mbambo Z, Myburgh KH. Running economy of African and Caucasian distance runners. *Med Sci Sports Exerc*. 2000;32(6): 1130–1134.
16. Onywera VO, Scott RA, Boit MK, Pitsiladis YP. Demographic characteristics of elite Kenyan endurance runners. *J Sports Sci*. 2006; 24(4):415–422.
17. Saltin B, Larsen H, Terrados N, et al. Aerobic exercise capacity at sea level and at altitude in Kenyan boys, junior and senior runners compared with Scandinavian runners. *Scand J Med Sci Sports*. 1995;5(4):209–221.
18. Saltin B, Kim CK, Terrados N, Larsen H, Svedenhag J, Rolf CJ. Morphology, enzyme activities and buffer capacity in leg muscles of Kenyan and Scandinavian runners. *Scand J Med Sci Sports*. 1995;5(4): 222–230.
19. Weston AR, Karamizrak O, Smith A, Noakes TD, Myburgh KH. African runners exhibit greater fatigue resistance, lower lactate accumulation, and higher oxidative enzyme activity. *J Appl Physiol*. 1999;86(3):915–923.

20. Baker J, Horton S. East African running dominance revisited: a role for stereotype threat? *Br J Sports Med*. 2003;37(6):553–555.
21. Hamilton B, Weston A. Perspectives on East African middle and long distance running. *J Sci Med Sport*. 2000;3(4):vi–viii.
22. Berthelot G, Len S, Hellard P, et al. Exponential growth combined with exponential decline explains lifetime performance evolution in individual and human species. *Age (Dordr)*. 2012;34(4):1001–1009.
23. Hunter SK, Stevens AA, Magennis K, Skelton KW, Fauth M. Is there a sex difference in the age of elite marathon runners? *Med Sci Sports Exerc*. 2011;43(4):656–664.
24. Njororai WWS. Global inequality and athlete labour migration from Kenya. *Leisure/Loisir*. 2010;34(4):443–461.
25. Njororai WWS. Distance running in Kenya: athletics labour migration and its consequences. *Leisure/Loisir*. 2012;36(2):187–209.
26. Leyk D, Erley O, Gorges W, et al. Performance, training and lifestyle parameters of marathon runners aged 20–80 years: results of the PACE-study. *Int J Sports Med*. 2009;30(5):360–365.
27. Rankinen T, Bray MS, Hagberg JM, et al. The human gene map for performance and health-related fitness phenotypes: the 2005 update. *Med Sci Sports Exerc*. 2006;38(11):1863–1888.
28. Hamilton B. East African running dominance: what is behind it? *Br J Sports Med*. 2000;34(5):391–394.
29. Nevill AM, Whyte G. Are there limits to running world records? *Med Sci Sports Exerc*. 2005;37(10):1785–1178.
30. La Torre A, Vernillo G, Agnello L, Berardelli C, Rampinini E. Is it time to consider a new performance classification for high-level male marathon runners? *J Strength Cond Res*. 2011;25(12):3242–3247.
31. Celie F, Faes M, Hopman M, Stalenhoef AF, Rikkert MG. Running on age in a 15-km road run: minor influence of age on performance. *Eur Rev Aging Phys Act*. 2010;7(1):43–47.
32. Leyk D, Rüther T, Wunderlich M, et al. Physical performance in middle age and old age: good news for our sedentary and aging society. *Dtsch Arztebl Int*. 2010;107(46):809–816.
33. Lee MS, Tanaka K. Significance of health fitness appraisal in an aging society. *Appl Human Sci*. 1997;16(4):123–131.
34. Gremeaux V, Gayda M, Lepers R, Sosner P, Juneau M, Nigam A. Exercise and longevity. *Maturitas*. 2012;73(4):312–317.
35. Zillmann T, Knechtle B, Rüst CA, Knechtle P, Rosemann T, Lepers R. Comparison of Training and Anthropometric Characteristics between Recreational Male Half-Marathoners and Marathoners. *Chin J Physiol*. 2013;30;56(3).
36. Vihma T. Effects of weather on the performance of marathon runners. *Int J Biometeorol*. 2010;54(3):297–306.
37. Williams J, Tzortziou Brown V, Malliaras P, Perry M, Kipps C. Hydration strategies of runners in the London Marathon. *Clin J Sport Med*. 2012;22(2):152–156.
38. Arrese AL, Ostáriz ES. Skinfold thicknesses associated with distance running performance in highly trained runners. *J Sports Sci*. 2006;24(1):69–76.
39. Schmid W, Knechtle B, Knechtle P, et al. Predictor variables for marathon race time in recreational female runners. *Asian J Sports Med*. 2012;3(2):90–98.